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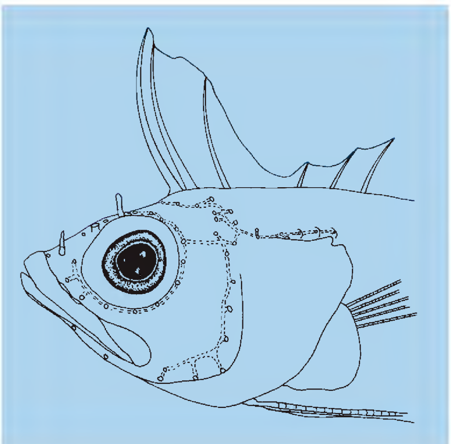

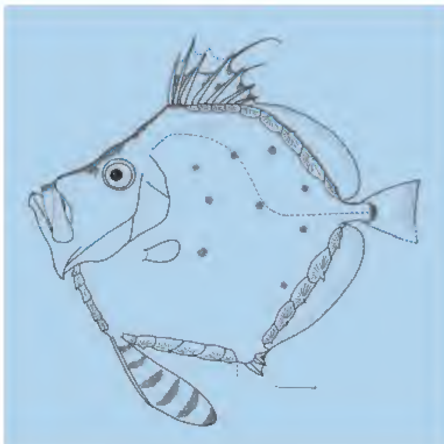

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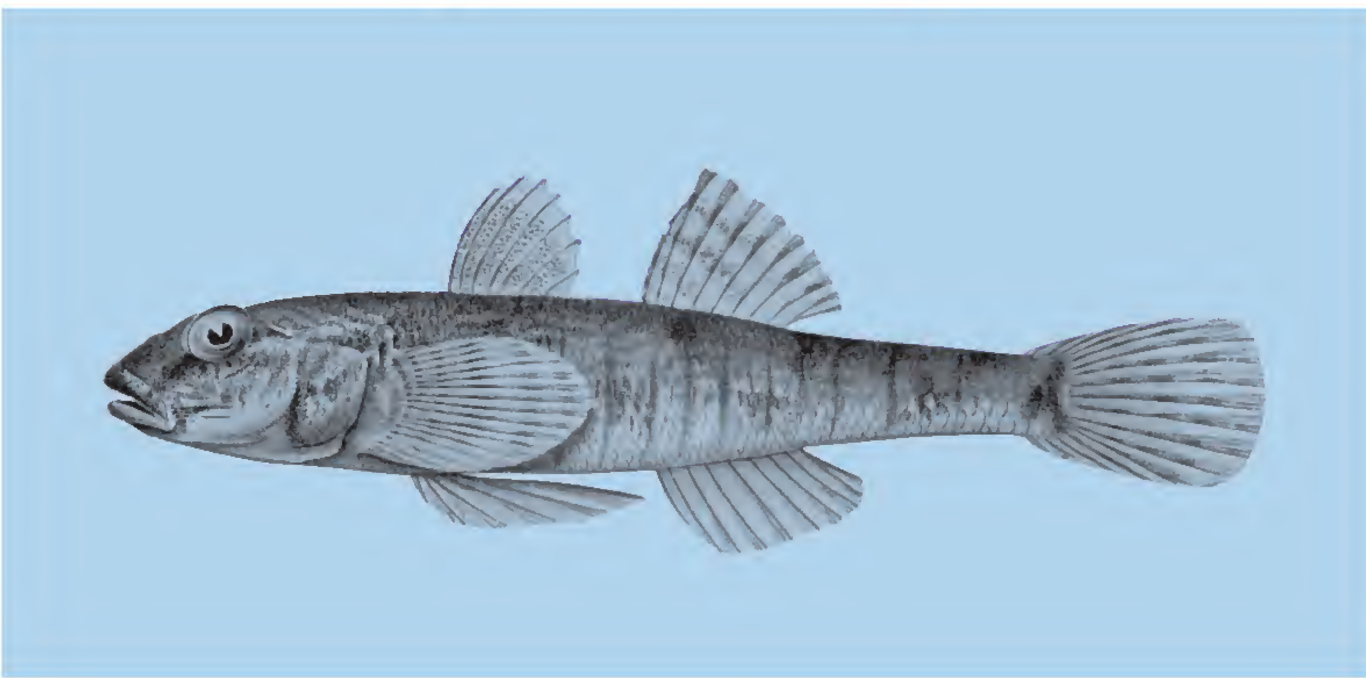

New species of Australian fishes

Illustrations of species of Australian fishes described in this special issue.
Front top left: head of the new weedfish *Heteroclinus kuiter* described by D.F. Hoese and D.S. Rennis.
Middle: juvenile of the new dory *Zenopsis stabilispinosa* described by T. Nakabo, D. Bray and U. Yamada.
Lower: the goby *Nesogobius maccullochi* redescribed by D.F. Hoese and H.K. Larsen (reproduced from McCulloch and Ogilby, 1919).
Back: the new trevally *Pseudocaranx dinjerra* described by W.F. Smith-Vaniz and H.L. Jelks.

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MELBOURNE AUSTRALIA

Memoir 63
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Museum Victoria, formerly the Museum of Victoria, was formed in 1983 by the merger of the National Museum of Victoria (established in 1854) and the Science Museum of Victoria (established in 1870). Museum Victoria undertakes research in order to contribute to a deeper understanding and appreciation of the origins, diversity and development of Australia's natural, cultural and scientific heritage, and applies this knowledge for the benefit of society. Museum Victoria publishes its scientific journal *Memoirs of Museum Victoria* (until 1983 *Memoirs of the National Museum of Victoria*) to further these objectives.

The *Memoirs* publishes papers on original research in the natural sciences pertinent to Victoria and/or the Museum's collections. All contributions are assessed by independent referees before publication.

From Volume 58 (2000) the *Memoirs* is available in electronic format as well as in printed form from the Museum Victoria website. Electronic publication will enable inclusion of supplementary information (such as extended data-sets) not available in the printed version.

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The *Memoirs of Museum Victoria* is published by order of the Museums Board of Victoria. Acceptance of papers is handled by the Editorial Committee which will seek the widest possible advice from referees. Papers should be submitted in the first instance to the Scientific Editor, Museum Victoria, GPO Box 666E, Melbourne, Vic. 3001, Australia (memoirs@museum.vic.gov.au).

Instructions to Authors

Three copies of the manuscript with accompanying plates and figures should be submitted to the Scientific Editor, Museum Victoria, GPO Box 666E, Melbourne, Victoria 3001, Australia (memoirs@museum.vic.gov.au). Authors should consult a recent volume of the *Memoirs* to aquaint themselves with format. Manuscripts must be typed on A4 paper, 1.5-spaced, on one side of the paper, or submitted totally in electronic form as attached files by email. Except for short papers (less than 10 manuscript pages) electronic presentation of the text and figures of the final accepted manuscript (on disk or as an attached emailed file) is essential. PC format is preferred.

Papers should be arranged as follows: title (including higher classification of zoological taxa); authors' names and addresses (postal and email); abstract; key words; contents (only if the paper is very long); introduction and main text; acknowledgements; references; index (only if very long); and tables. Captions to text-figures and plates must be attached to the manuscript as final pages. Primary headings are in bold and left-justified; secondary headings in italics and left justified. Italics in the text should otherwise be restricted to generic and specific names. Paragraphs are indented with tabs. Measurements must be in the metric system (SI units).

Figure captions should follow this example:

Figure 1. *Storthyngurella hirsuta* sp. nov., male, holotype: a, b, dorsal and lateral views of body; c, d, frontal and lateral views of cephalon.

References should be listed alphabetically at the end of the manuscript. Journal titles must be in full. References to books must give the year of publication, edition, name of publisher and city of publication. Use the style and punctuation in the following examples for articles, books and chapters:

Paulin, C.D. 1986. A new genus and species of morid fish from shallow coastal waters of southern Australia. *Memoirs of Museum Victoria* 47: 201–206.

Last, P.R., and Stevens, J.D. 1994. *Sharks and rays of Australia*. CSIRO Publishing: Melbourne. 513 pp.

Wilson, B.R., and Allen, G.R. 1987. Major components and distribution of marine fauna. Pp. 43–68 in: Dyne, G.R. and Watson, D.W. (eds), *Fauna of Australia. General articles*. Vol. 1A. Australian Government Publishing Service: Canberra.

Reference citations use the following style: Paulin, 1986; Last and Stevens, 1994; Smith et al., 1990.

In taxonomic papers synonymies should be of the form: taxon, author, year, pages, figures. A period and dash must separate taxon and author except in the case of reference to the original description, e.g.

Leontocaris Stebbing, 1905: 98–99.—Barnard, 1950: 699.

Photographs must have clear definition and be submitted as either glossy or flat prints at the actual size for reproduction, or preferably as electronic files. Line drawings for text-figures should be in black ink on white card or drawing film, Original line drawings up to three times final size are acceptable but scanned B&W images at 600 dpi are preferred. Maximum full-page size is 175 mm wide by 224 mm; single column width is 85 mm. Clear lettering must be inserted.

Supplementary information (extended lists of material examined, databases etc.) should be submitted electronically with the original manuscript and will be included with material sent to referees. The Editorial Board encourages use of supplementary information to minimise the cost of printing as long as the requirements of the International Code of Zoological Nomenclature are met in the printed paper.

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ɩ pecial issue – New species of Australian fishes

Memoirs of Museum Victoria volume 63 issue 1

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This issue of the *Memoirs of Museum Victoria* presents a selection of papers on the taxonomy of fishes intended to improve our understanding of Australian fish biodiversity. It is the third in a series of such publications, the first appearing in 1987 as Volume 48, Number 1 of the *Memoirs of the Museum of Victoria*. Intended as a venue for new names and descriptions of recognised, but formally undescribed, species, the volume contained 20 papers by 15 authors that described as new two genera and 33 species. As a continuing initiative of OzFishNet, a consortium of collection-based Australian ichthyologists formed to promote research, data access and other issues of mutual interest to the Australian community (http://www.amonline.net.au/FISHES/ozfishnet/), a second publication, Volume 56, Number 2 of the *Records of the Australian Museum* published in 2004 contained descriptions of an additional genus and 33 species. In that volume, the 17 papers authored by 21 scientists also clarified inadequate perceptions of related Australian forms.

The current issue was conceived prior to the publication of the 2004 volume of the *Records* to pick up the overflow of papers expected for that publication, knowing that its accelerated publication time line would be beyond the capability of some intended contributors. Like its predecessors it is also intended to continue the publication of names and descriptions so that scientific colleagues have the means to better understand the natural environment with which they are working. The present contribution contains 12 papers by 19 authors and describes a new genus and 15 species, as well as clarifying our understanding of closely related forms and laying out a worldwide taxonomic framework for a family having more than 70 nominal species.

Although these publications provide important steps toward a full documentation of Australia's fish fauna, the job is far from complete. Despite a decline in number of taxonomic ichthyologists in Australia and a reduction in number of positions for members of the profession in Australian institutions, new fishes continue to be discovered at about the same rate as they have at any time in the last 25 years. The rate of their discovery approximates the rate at which new species are being described. A dedicated group of scientists continue to work away, behind the scene, to further this tradition.

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A new species of *Neamia* (Perciformes: Apogonidae) from the West Pacific Ocean

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Abstract

Fraser T.H. and Allen G.R. 2006. A new species of *Neamia* (Perciformes: Apogonidae) from the West Pacific Ocean. *Memoirs of Museum Victoria* 63(1): 1–5.

A new species of apogonid fish, *Neamia articycla*, is described from Australia, Indonesia, Philippines and Fiji, bringing the total number of described *Neamia* spp to three. It is distinguished from *Neamia notula* in preservation by: a circular, ocellated dark spot rather than one that is oval-shaped and flattened along its anterior margin, with an outer, narrow darkish edge clockwise dorsally from abutting edge of preopercle around to meeting ventral abutting edge of preopercle, a faint, narrow, horizontal line of melanophores below the eye reaching the preopercle ridge; in life no darkish marks behind the eyes, a circular spot with pale outer band without dark edging instead of an oval spot flattened along preopercle edge with a darkish edge; five predorsal scales instead of four; usually 22 pored, lateral-line scales instead of 23 and a longer pectoral fin. *Neamia articycla* can be distinguished from *Neamia octospina* by having 14 pectoral rays instead of 17–21 and by having seven visible first-dorsal spines instead of eight.

Keywords Apogonidae, *Neamia articycla*, *Neamia notula*, cardinalfish, new species *Apogonichthys*, *Foa*, *Fowleria*.

Introduction

Ichthyologists collecting from poorly sampled habitats in depths of 10–40 m continue to find new species of cardinalfish. We describe here a new *Neamia* which is associated with *Halimeda* beds growing in deeper coral reef systems of the western Pacific Ocean. The new species represents the third known species in this clade. There may be other material in museums identified as *Fowleria* because of the similar physiognomy. *Neamia* spp can be distinguished from similar *Fowleria* species by the following characters: fused hypurals in the caudal-fin skeleton, completely pored lateral-line scales in adults (versus partially pored and then pitted, except one undescribed species of *Fowleria*), cycloid scales on the head and anterior portions of the body (weakly ctenoid scales on the nape for species of *Fowleria*, elsewhere on the head, weak to strongly ctenoid scales and ctenoid on entire body).

Methods for counts and measurements were described in detail by Fraser and Lachner, 1985. All measurements are in mm to the nearest 0.1. Percentages are of standard length. Institutional acronyms follow Eschmeyer, 1998 and Leviton et al., 1985. Field station numbers are listed for additional collection information, for example, VGS 69–23. Radiographs (X-rays) have been taken from type material. A camera lucida attachment on a Wild microscope and a needle blowing air were used to make the diagrammatic drawings of the pores. The description of pores refers to larger and to smaller perforations (referred to as minipores) of the skin over the canal systems of the head. The latter are sometimes obscured by congealed mucous.

Neamia Smith and Radcliffe in Radcliffe, 1912

Type species. *Neamia octospina* Smith and Radcliffe in Radcliffe, 1912.

Diagnosis. An apogonine with 3 hypurals, 1 and 2 fused, 3 and 4 fused, 5 free, hypurals 3+4 fused to urostylar centrum; 1 pair of reduced or slender uroneurals; 3 epurals; 3 supraneurals; 2 supernumerary dorsal-fin spines; smooth preopercle edges and ridge, smooth post-temporal; no basisphenoid; a reduced, tiny supramaxilla; no palatine teeth; scales on cheek and opercle cycloid; lateral-line scales extending from post-temporal to base of caudal fin, all ctenoid with simple pores; rounded caudal fin; 9 dorsal-fin spines, 8th spine visible or hidden by skin, dorsal fin deeply notched and considered separate, the 9th spine at beginning of 2nd dorsal fin; dorsal-fin rays 9; anal-fin rays 8; pectoral-fin rays 13–21; pale stomach, intestine and peritoneum.

Neamia articycla sp. nov.

Figures 1–4

Holotype. AMS I.25121-005; 1, 35.5; Australia, Great Barrier Reef, Qld, 14°41'S, 145°30'E, east of Lizard I.; 31 Jan 1982; 36–38 m, J. Leis.

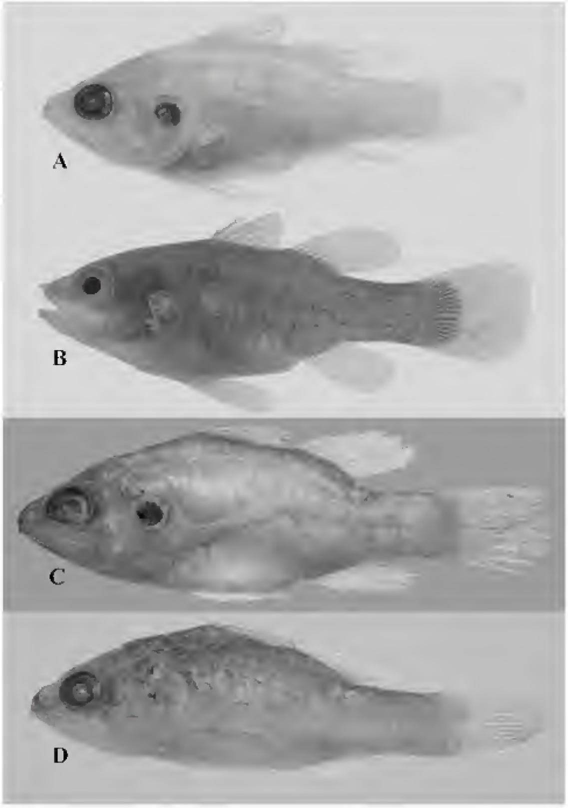

Figure 1. *Neamia articycla*: A. Holotype, AMS I.251221-005, 35.5 mm SL (preserved), Australia, Qld, east of Lizard I.. B. Paratype, USNM 370291, 23.5, mm SL, Philippines, Mindanao I., modified from colour image of a fresh specimen by J. T. Williams. C. Paratype, USNM 209665, 32.4 mm SL (preserved), Indonesia, Moluccas, Ceram I. D. Paratype CAS 223500, 32.9 mm SL (preserved), Fiji, Viti Levu, Nananui-i-cake I.

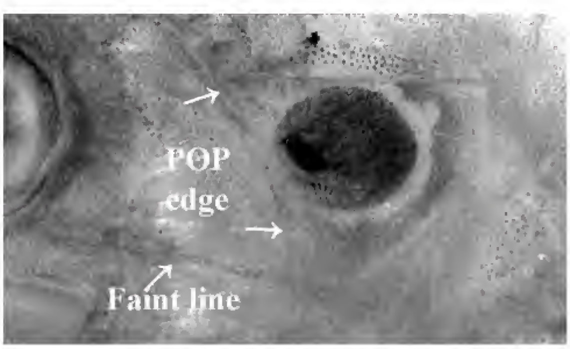

Figure 3. Post-ocular melanophore patterns on the cheek (faint line) and circular spot with pale interval and outer edging of melanophores starting along posterior edge of preopercle (POP). USNM 209665 paratype, 32.4 mm SL (preserved).

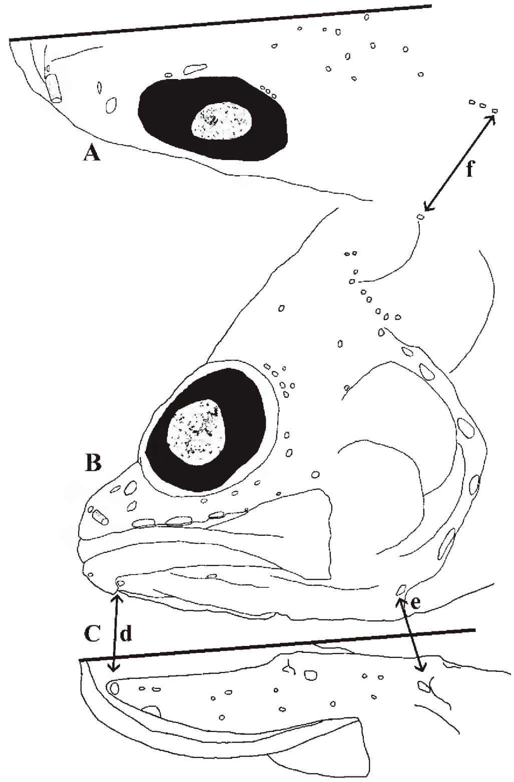

Figure 2. Cephalic lateralis system of pores on the head of the holotype, *Neamia articycla*. A. Dorsal view. B. Lateral view slightly tilted. C. Ventral view of dentary-articular. d. ventral mandibular pore. e. posterior articular pore. f. post-temporal pore.

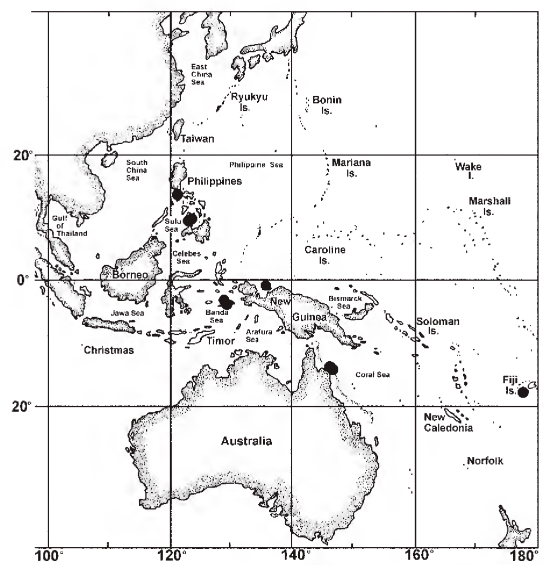

Figure 4. Distribution of the collections sites for *Neamia articycla*.

Paratypes. Pacific Ocean: Indonesia: USNM 209665; 8, 14.2–32.3; Ceram, Piru Bay; VGS 73–6; 10 Jan 1973; 8 m. USNM 209929; 5, 22.5–27.7; Saparua; VGS 73–14; 18 Jan 1973; 9 m; X-ray. Fiji: CAS 223500; 1, 32.9; 17°19.462'S, 178°14.250'E, Nananui-i-cake I., Viti Levu; G02-76; 15 Mar 2002; 1–3 m, colour transparency. Australia, Qld: AMS I.40665-004; 1, 34.3; & AMS I.40665-005; 1, 17.0; 14°38.20'S, 145°32.30'E, between Lizard I. & Yonge Reef, Great Barrier Reef; 26 Jan 2001; 27 m. AMS I.40666-012; 1, 31.1 & AMS I.40666-013; 1, 19.0; 14°38.16'S, 145°32.16'E, between Lizard I. & outer barrier reef, Great Barrier Reef; 29 Jan 2001; 25 m, colour digital photos. Philippines: USNM 370291; 1, 23.5; 13°10.04'N, 120°35'12'E, Mindanao I.; Min00-62; 3 Jun 2000; 30 m; X-ray, colour digital photos.

Non-type material. Indonesia: USNM 209847; 3, 10.0-20.4; Ceram, Piru Bay; VGS 73-5; 9 Jan 1973; 5–7 m, WAM P.32771-002; 23.4; 01°36.252'S, 135°24.553'E, Tanjung Woka, Yapen I., Papua, Indonesia; 13 Feb 2006; 34 m. Philippines: USNM 369983; 2, 18.0-27.4; 13°45'N, 120°55'E, Anilao, Batangas; 26 Apr 1980; 22 m. USNM 268318; 1, 32.6; 9°04'38'N, 123°16'44'E, Apo I.; SP78-36; 7 Jun 1978; 39 m.

Other material. *Fowleria* sp. AMS I.23585-001; 1, 45.0; 14°34'S, 145°34' E, south-west of Carter Reef, Great Barrier Reef, Australia; 31 Jan 1982; 30 m, J. Leis. *Apogonichthys nafae* Holotype, USNM 62947; 22.1; Japan, Okinawa, Naha.

Diagnosis. A species of *Neamia* with 7 visible first-dorsal spines, 8th spine hidden by skin, darkish circular spot on the opercle below opercular spine within a pale area; in life, body uniformly reddish to brownish, all fins pale, 13–14 pectoral rays, 5 predorsal scales, eye diameter 10–12%, pectoral fin 25–31% and body depth 37–40% of standard length.

Description. For general body shape see fig. 1a–d. Holotype proportions and characteristics first with range of values in parentheses for paratypes and other material. Proportions as % of standard length: greatest body depth 37.4 (34–40); head length 44.6 (41–46); eye diameter 10.0 (11–12); snout length 8.3 (8–10); bony interorbital width 3.7 (4–6); upper jaw length 20.3 (20–22); caudal peduncle depth 15.7 (15–17); caudal peduncle length 20.9 (19–22); 1st dorsal-fin spine length 1.7 (2–4); 2nd dorsal-fin spine length 6.6 (6–10); 3rd dorsal-fin spine length 16.9 (16–21); 4th dorsal-fin spine length 16.0 (16–19); spine in 2nd dorsal fin 9.7 (9–12); 1st anal-fin spine length 2.0 (2–5); 2nd anal-fin spine length 10.0 (8–12); pectoral fin length 28.9 (25–31); pelvic fin length 25.7 (24–30).

Dorsal fin VII(I)-I,9, 8th spine hidden under skin, 3rd and 4th spines about the same thickness; anal fin II,8; pectoral fin 14; pelvic fin I,5; principal caudal rays 9+8; caudal fin rounded; pored lateral-line scales 22 (11–12 for specimens 17–20 mm SL, 18 for specimens 20–24 mm SL, 22–23 in specimens greater than 26 mm SL); transverse scale rows above lateral line 2; transverse scale rows below lateral line 6; median predorsal scales 5; circumpeduncular scale rows 12 (5+2+5). Total rudiments and gill rakers 15 (13–15), 2+1-5+7 (1-2+1-5-6+5-7), well developed gill rakers 6 (6–7), upper arch 1(1), lower arch 5 (5–6). Rudiments on lower arch as flattened tooth patches. 2nd arch with 1 short, nob-like raker in angle, upper arch with 1–2 flattened tooth patches, lower arch with 5–6 nob-like rakers followed by flattened tooth patches.

Villiform teeth in a band of about 5 rows becoming 2–3 rows on side of premaxilla; villiform band of about 5 rows becoming 2–3 rows on side of dentary; 3–4 rows of villiform teeth on vomer; none on palatine, ectopterygoid, endopterygoid or basihyal.

Vertebrae 10+14. 3 hypurals 1+2 fused, 3+4 fused to urostylar centrum, 1 pair uroneurals, 2 large epurals (a 3rd epural could not be identified from the radiograph), a free parhypural. 3 supraneurals, 2 supernumerary spines on 1st dorsal pterygiophore, 8th dorsal-fin spine hidden as a nubbin. Basisphenoid status unknown, lower portion apparently absent, but unclear on X-ray. Status of suspensory pharyngeal unknown. Supramaxilla present. Posttemporal smooth on posterior margin. Preopercle smooth on vertical and horizontal margins. Infraorbital edges smooth.

Cephalic pored sensory system (fig. 2) – all larger pores bilateral. No variation for the following pores: 2 nasal pores at anterior end of supraorbital canal system, 1 medial to tubular anterior nare, 1 slightly anterior and medial to posterior nare, 1 near edge of orbit on interorbital; 4 infraorbital pores at anterior part of infraorbital canal, 1 between ventral edge of lachrymal and flat posterior nare, 2 on ventral edge of lachrymal, 1 on ventral edge of 2nd infraorbital; dentary with 3 pores at anterior end of mandibular canal, 1 on tip of lip, 1 behind lip, and 1 lateral; 7 articulo-preopercular pores near posterior edge along the preopercular canal. Variation in number and location of minipores: supraorbital with none or 1 pore near edge of orbit on interorbital area; paired pores along upper and lower portions of infraorbitals below orbit; dentary and articular with 4 pairs (inner and outer) of posterior pores, with several unpaired pores on dentary and articular; preopercular minipores along narrow upper portion of preopercle. Minipores variably present posterior to eye on upper portion of infraorbitals, on nape and above preopercle ending on the post-temporal.

All scales cycloid on head, nape and breast. Scales becoming ctenoid above breast and behind pelvic fin. Scales above lateral line ctenoid. All lateral-line scales ctenoid, except first. Pored lateral-line scales simple (with 1 opening above and below main pore), extending from post-temporal to base of caudal fin.

Life colours. Colours based on photographs are from fresh dead specimens shortly after collection. From B. M. Carson-Ewart photograph (AMS I.40666-012) – body, pelvic, caudal and dorsal fins orangish red, flank grading to white on abdomen; head without marks extending from orbit edge, lips whitish; circular spot on opercle yellowish with faint outer margin of melanophores dorsally, large inner circle of dark melanophores about size of pupil; iris whitish with narrow inner ring of light yellow surrounding pupil.

From B. M. Carson-Ewart photograph (AMS I.40666-013) – body and caudal fins a pale orangish red to more yellowish posteriorly, with brownish marks in caudal fin, flank grading to white on abdomen; head without marks extending from orbit edge, lips whitish; circular spot on opercle yellowish with outer margin ring (~270°) of melanophores except posteriorly, large inner circle of dark melanophores about size of pupil; iris whitish with narrow inner ring of light yellow surrounding pupil.

From D. W. Greenfield photograph (CAS 223500) – body and caudal fin dark brownish, head without markings extending

from orbit edge, lower half of head and breast tannish white extending posteriorly to opercular spot and then above pectoral-fin base descending to near anal base; pelvic fins whitish; spot on opercle whitish tan with inner darkish ring smaller than eye diameter; iris tannish white with narrow inner ring of light yellow surrounding pupil.

From J. T. Williams' photograph (USNM 370291) – body generally uniform brownish, with 2 rows of small spots along caudal peduncle, about 5 pairs, 3 spots extended anteriorly in the lower row with 2 spots below the 3 spots; head without markings extending from orbit edge; all fins generally pale with numerous small melanophores in caudal fin; round spot on opercle with complete brownish outer edge of body colour around pale area with large dark inner spot; narrow whitish bars on lower lip; iris orangish.

Colour in ethyl alcohol. Holotype uniform light tannish in alcohol with tiny melanophores on head, body, both dorsal fins, denser on membranes of 2nd dorsal fin, melanophores absent on anal, pelvic and pectoral fins; large rounded dark spot on opercle, surrounded by pale area, melanophores at edge of pale zone forming about a half-circle; faint series of melanophores in a horizontal line from lower orbit to preopercular ridge (fig. 3). Pale stomach, intestine and peritoneum. Paratypes and non-type material uniform brownish to tannish in alcohol with tiny melanophores on head, body, both dorsal fins, denser on membranes of 2nd dorsal fin, melanophores absent on anal, pelvic and pectoral fins; large rounded dark spot on opercle, surrounded by pale area, melanophores at edge of pale zone forming about a half-circle; faint, darkish, horizontal line of melanophores from lower orbit to preopercular ridge; lips with a few narrow pale bars or lips indistinct.

Etymology. The Greek words *artios*, complete or perfect and *cyclus*, circle as *articycla* an adjective referring to the dark spot on the opercle with its edge as a complete or perfect circle.

Distribution. The new species is apparently widespread in the western Pacific from Sumatra to Fiji, and eastern Australia north to the Philippines (fig. 4). Although it has been collected at relatively few locations, future collections will no doubt expand the known distribution. Due to their cryptic habits, the species of *Neamia* are seldom observed by divers, rather they are collected with ichthyocides, dredges and sleds. Collection data suggest *N. articycla* frequents the 10–40 m depth zone, in association with beds of a calcareous algae, *Halimeda* or calcareous rubble, sometimes mixed with the pocilloporid coral *Seriatopora hystrix*. The URL http://www.amonline.net.au/fishes/about/research/halimeda.htm has more information about other fishes collected in such *Halimeda* beds and a link to colour photographs of this species.

Remarks and discussion. Neamia articycla has an ocellated opercular spot that in life lacks an outer dark margin posteriorly, but in preservation has a darkish edge from dorsal edge abutting preopercle around to ventral edge abutting preopercle. It has no darkish marks behind the eyes in life, but in preservation does have a faint, narrow, horizontal line of melanophores below the eye reaching the preopercle ridge. In contrast, *N. notula* has an oval spot flattened along the preopercle edge with a darkish edge outside of the pale area in life, four predorsal scales instead of five, usually 22 pored, lateral-line scales instead of 23 and a longer pectoral fin. *Neamia articycla* can be distinguished from *Neamia octospina* by having 14 pectoral rays instead of 17–21 and by having seven visible first-dorsal spines instead of eight.

Fraser and Allen, 2001 discussed the relationships of *Neamia* with other apogonid genera. *Neamia articycla* does not have characters that alter that discussion. *Neamia articycla* is more similar to *N. notula* based on the presence of the opercle spot, the reduced, hidden, eighth dorsal spine, larger eye and the lower pectoral fin-ray count than to *N. octospina*. Specimens of *N. articycla* less than about 25 mm SL have incompletely pored lateral-line scales (the number of pored scales varies with size) and may therefore be confused with *Fowleria*, most species of which have an incomplete lateral line – see the figure of *Fowleria nafae*, Snyder, 1909 in Snyder, 1912 one of the nominal species originally described as *Apogonichthys nafae*.

Some similarities exist between *N. articycla* and species of *Fowleria*. The ocellus-like opercular spot, tubular anterior nare, lack of palatine teeth and body shape are characteristics *N. articycla* shares with most species of *Fowleria*. However, these genera can be distinguished by fused caudal skeletal characteristics in *Neamia*, completely pored lateral-line scales in adult *Neamia*, (number of pitted scales in *N. articycla* decreases posteriorly with growth, unlike *Fowleria*), and cycloid scales on the head and anterior portions of the body (weakly ctenoid scales on nape for species of *Fowleria*, elsewhere on head weak to strongly ctenoid scales and ctenoid on body). Bergmann, 2004 noted some variation in the pore pattern on the dentaries for the four species of *Fowleria* examined. None appeared to be similar to *N. articycla* in spatial organization, with *F. vaiulae* perhaps having a few of its slightly larger minipores spaced and located in a similar fashion.

Ida and Moyer, 1974, fig. 3 compared the cephalic lateralis and free neuromasts of five genera of cardinalfishes (including three subgenera), *Apogon* (*Ostorhinchus*), *Apogon* (*Apogon*), *Fowleria*, *Cheilodipterus*, *Rhabdamia* (*Verulux*), and *Pseudamia*. Bergmann, 2004 provided a more extensive survey of these systems for these same genera and another 30 apogonid genera and subgenera in two subfamilies. Species of *Neamia* differ most obviously from illustrations of *Fowleria*, *Foa*, and *Apogonichthys* in having fewer pores on the dentary. A comparison of the descriptions of *Neamia* suggest that *N. octospina* and the holotype of *N. articycla* show similarities in the three slit-like pores along the ventral edge of the lachrymal (first infraorbital) and second infraorbital, three suborbital pores and the paired dentary pores. Differences were apparent: location of the anterior-most supraorbital pore back near the anterior nare in *N. articycla*, slit-like in *N. octospina* located along the margin with the premaxilla; larger pores along the posterior edge of the subopercle-preopercle in *N. articycla* than for *N. octospina,* and no mini-pores just posterior to the preopercle ridge in *N. articycla* versus numerous minipores; few paired pores on the dentary and articular in *N. articycla* versus numerous paired pores; no minipores in *N. articycla* versus many minipores on snout and interorbit; and fewer minipores on the nape in *N. articycla* versus widespread and numerous.

Ida and Moyer, 1974 failed to indicate the taxonomic value of pore characteristics, although their fig. 3 was suggestive. Bergmann, 2004 found four characteristics of the cephalic lateralis which were shared by all cardinalfishes examined. *Neamia articycla* has these four characteristics: a terminal lachrymal pore, a pair of ventral lachrymal pores, an anterior dentary pore in the lower lip and a mental (ventral dentary pore) immediately behind the lower lip. Bergmann, 2004 identified eight characteristics that had variation, and proposed that these various states had phylogenetic value within cardinalfishes. *Neamia articycla* has: (1) the terminal end of the supra-orbital canal ending in a large pore near anterior nare; (2) the lateral margin of the supra-orbital canal near the posterior nare with a single large pore; (3) the lateral margin of the supra-orbital canal midway on interorbit with a large pore, but also with an additional smaller anterior pore (variably present) apparently intermediate to having multiple canal projections; (4) the postorbit pores with simple canal projections with minipores; (5) the supratemporal canal anterior margin smooth; (6) the supratemporal canal posterior margin with few canal projections with minipores; (7) the lateral margin of the mandibular canal with relatively large and simple pores; and (8) a terminal mandibular pore (here called the posterior articular pore) near the boundary with the preopercle. The usefulness of these eight characteristics and their character states will be further developed through examination of many species not yet reported in the literature. Many of the other minipores had some variation in number and location among individuals of *N. articycla*.

Acknowledgments

We thank D. G. Smith, J. T. Williams (USNM), David Catania and David W. Greenfield (CAS), and Mark McGrouther (AMS) who aided in curatorial processes and loan of fishes. D. G. Smith provided X-rays. L. M. R. Bergmann allowed us the use of illustrations and information from her dissertation. D. W. Greenfield, J. M. Leis (taken by B. M. Carson-Ewart) and J. T. Williams provided colour images of the new species. Useful comments were provided by D. W. Greenfield, J. M. Leis and an anonymous reviewer.

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Description of two new species of *Nesogobius* (Pisces: Gobioidei: Gobiidae) from southern Australia

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Abstract Hoese, D.F. and Larson, H.K. 0000. Description of two new species of *Nesogobius* (Pisces: Gobioidei: Gobiidae) from southern Australia. *Memoirs of Museum Victoria* 63(1): 7–13.

Two new species of *Nesogobius* are described from southern Australia and compared with described species *Nesogobius pulchellus* Castelnau and *Nesogobius hinsbyi* (McCulloch and Ogilby). *Nesogobius greeni*, sp. nov. differs from *N. pulchellus* in lacking a spine in the second dorsal and anal fin and in lacking head pores. *Nesogobius maccullochi* sp. nov. differs from *N. hinsbyi* in having head pores and fewer dorsal spines and dorsal and anal rays.

Keywords Fish, Gobioidei, Gobiidae, gobies, *Nesogobius*, new species

Introduction

The genus *Nesogobius* is confined to southern Australia. The species live over and bury in fine sand. Currently the genus contains two previously described species, *Nesogobius hinsbyi* (McCulloch and Ogilby) and *Nesogobius pulchellus* (Castelnau). Several species are known (Hoese and Larson, 1994). The two species described here have been confused with the previously described species and are named to remove that confusion. Two species have been confused under the name *Nesogobius hinsbyi*. That species is known from deep water, but the name has been incorrectly applied to a common shallow-water species. Similarly two species have been confused under the name *Nesogobius pulchellus*, but both of these species are known from shallow water and often occur together. Other species will be treated in a more comprehensive review of the genus in preparation by the authors.

Hoese (1991) suggested a possible relationship of *Nesogobius* with *Tasmanogobius*, also restricted to southern Australia. Both genera have a poorly developed posterior connection of the neural arch to the centrum on all vertebrae. The genus is atypical in having a mixture of characteristics of taxa belonging to the Gobionellinae and the Gobiinae. For example, species of Gobionellinae normally have two epurals (Pezold, 1993), but *Nesogobius* is variable, with some species having one epural and some two. In gobionellines, the interorbital canal is separated anteriorly between the eye, with paired anterior interorbital pores and posterior and anterior nasal pores. In gobiines, when pores are present, the canals are fused between the eyes, usually with a median anterior interorbital pore (only paired in one species of *Glossogobius* or rarely paired in aberrant specimens) and no anterior nasal pore. In *Nesogobius*, when pores are present, the head canals are fused between the eyes, with a single anterior interorbital pore, as in gobiines, but with posterior and anterior nasal pores as in gobionellines.

Methods

Counts and measurements follow Hoese (1991). Institution abbreviations follow Levinton et al. (1985). The longitudinal scale count was taken from behind the pectoral base to the end of the caudal peduncle and is a count of scale rows, rather than a straight line count. The transverse scale count (TRB) is taken from the anal origin upward and backward to the second dorsal base. In descriptions an asterisk indicates count of holotype.

Comparative material examined: *Nesogobius hinsbyi* - Holotype TMH D.142, 1(62), Derwent R., Tas. AMS I.22569-001, 5(37–50), Derwent R., Tas. *Nesogobius pulchellus* - AMS I.16251-001, 7(37–42), Sydney Harbour, NSW.

Nesogobius Whitley, 1929

Nesogobius Whitley, 1929: 62 (type species *Gobius hinsbyi* McCulloch and Ogilby, 1919, by original designation).

The genus is unique in Australia in having only 13 segmented caudal rays. The genus contains 11 species all confined to southern Australia from central New South Wales to Perth, Western Australia. Most species are known only from Victoria, Tasmania and South Australia.

Nesogobius greeni sp. nov.

Figures 1–4

Nesogobius sp. 2.- Last, Scott and Talbot, 1983: 450, fig. 30.127 (Tas.).

Nesogobius sp. 3. – Hoese and Larson, 1994: 797, fig. 703 (southern Australia)

Material examined. Holotype: AMS I.25944-011, 30.5 male, Richards Point, Port Phillip Bay, Jan 1981, R. Kuiter. Paratypes: NSW: AMS I.20021-006, 1(27), Merimbula. Vic.: AMS I.25944-001, 6(17-30), taken with holotype; NMV A.29344-001, 2(30-30), Crib Point, Western Port, 4 Sep, 1974, Melbourne Univ. Zool. Dept., 0415 hr; NMV A.29345-001, 1(32), Crib Point, Western Port, 18 Oct, 1974, Melbourne Univ. Zool. Dept., 1100-1130 hrs; NMV A.29346-001, 2(30-30), Crib Point, Western Port, 20 Aug, 1974, Melbourne Univ. Zool. Dept., 0500 hrs; NMV A.29348-001, 6(27-29), reef at Beaumaris, Port Phillip Bay, 9 Jun, 1967, R. Frankenburg; NTM S.16206-001, 3(21–29), taken with holotype; AMS I.22572-006, 2(25–26), Swan Bay, Port Phillip Bay. Tas.: AMS IA.3621, 6(16–32), Southport, 1.5 fathoms, 9 Feb, 1928, T.T. Flynn; AMS I.43821001, 1(24), D'Entrecasteaux Channel, P. Last; AMS I.43824-001, 4, (26–30), D'Entrecasteaux Channel, P. Last, 3 Jul 1974; AMS I.17549-001, 6(15–24), Oyster Cove, 1 Dec, 1972, D. Hoese and W. Ivantsoff; AMS I.43825-001, 1(25), Margate, 11 Nov, 1973, T. Walker; AMS I.43822-001, 1(25), Margate, 12 Dec, 1973, T. Walker; AMS I.43818001, 8(19–31), Margate, 27–28 Jan, 1974, T.M. Walker; AMS I.17193-006, 2(27–31), Wedge Bay, May, 1976, T. Garrard; AMS I.43823-001, 1(25), Margate, 16 Jun, 1976, T. Walker; CSIRO T.1400, 1 (37), Port Davey, Kelly Basin, southwest Tas., 2 m, Mar 1979, P. Last; NMV A 29347-001, (ex QVM 1972/5/425E), 10(32–37), Kelso, R. Greene, 5 Feb 1967; QVM 1972/5/2275, 3,(19–35), Greens Beach, 8 Jan, 1967; QVM 223, 5(17–37), Greens Beach, 26 May, 1972; QVM 224, 10(26–34), Greens Beach, 5–7 Nov, 1966, R. Green; QVM 225, 6(26–34), Greens Beach, 5 Feb, 1967, R.H. Green; QVM 226, 1(35), Greens Beach, 13 Jan, 1968, R. Green. SA: AMS I.20178-010, 3(19–20), Pelican Lagoon, Kangaroo I., 8 Mar, 1978, D. Hoese and Party.

Non-type material. Tas.: CSIRO (unreg.) 3(26–36), D'Entrecasteaux Channel, 3 Jul 1974; CSIRO (unreg.) 4(26–32), Fortesque Bay, 10 m, P. Last; CSIRO T.103, 1(28), Parsons Bay, Nubeena, 2 Nov 1978; CSIRO T.123, 1(31), Bayview Beach, Georges Bay, 2 Nov 1978; CSIRO T.1665, 1(26), Dru Point, 10 Apr 1980, University of Tasmania; CSIRO T.174, 1(36), Ansons Bay, 25 Mar 1978,P.J. Miller; CSIRO T.185, 1(37), Ansons Bay, 11 Oct 1978; CSIRO T.186, 1(29), Ansons Bay, 11 Oct 1978; CSIRO T.184, 1(38), Boggy Creek Beach, St. Helens, Jul 1978.

Diagnosis. 1st dorsal fin VII; 2nd dorsal-fin rays 8–11, rarely 8 or 11; anal-fin rays 8–10; no spine in 2nd dorsal or anal fin; branched caudal-fin rays 11–12; pectoral-fin rays 16–20; no head pores; gill opening wide, reaching forward to below or slightly before posterior preopercular margin; head with scales reaching to above preoperculum, sometimes almost to eye; dorsal mid-line of nape naked or rarely with a single scale just before 1st dorsal fin, but scales often present just to side of midline; body scales ctenoid, in 25–30 rows; midline of belly without scales or with a few scales posteriorly; pectoral base usually without scales or with 1 or 2 cycloid scales ventrally; area before pelvic fin with cycloid scales; body deep, depth at anal origin subequal to or greater than caudal fin length; 1st dorsal fin low, with rounded or triangular-shaped margin.

Description. Based on 44 males and 55 females. 1st dorsal 6(3), 7(74*); 2nd dorsal-fin rays 8–10 (see Table 1); anal-fin rays 8(15), 9(77*), 10(25); pectoral-fin rays 16(6), 17(41*), 18(52), 19(2); segmented caudal-fin rays 13(54*), 14(2); branched caudal-fin rays 10(1), 11(14*), 12(27), 13(4) midline predorsal scales 0(38), 1(2); total gill rakers 4(2), 6(5), 7(3), 8(3), 9(3); lower gill rakers on 1st arch 4(2), 5(1), 6(7), 7(2), 8(4), 9(1); lower gill rakers on 2nd arch 4(1), 5(5), 6(5); longitudinal scale count 25(6), 26(9), 27(16*), 28(7), 29(1), 30(1); TRB 7(3), 8(24), 9(2*). Head (28–32% SL), about as broad as deep; mouth small, oblique, forming an angle of 30–40° with body axis, rear end of jaws below front quarter of eye; tongue tip truncate to slightly emarginate; posterior nostril at end of short tube, almost touching eye; anterior nostril at end of short tube, positioned midway between eye and upper jaw, close to posterior nostril; snout convex in side view, forming an angle of about 45° with body axis; upper lip thick anteriorly, thin posteriorly; lower lip thin with shallow free ventral margin separating lip from mental frenum; chin with round mental frenum with a small sensory papilla at each side; eye large subequal to snout; gill rakers on outer face of 1st arch 0–1 + 4–9 = 4–8, rarely 4 or 5; rakers very short on both faces of all arches; teeth in upper jaw small, conical and wide-set, 3–4 inner rows of close-set teeth anteriorly tapering to 2 rows laterally; teeth in lower jaw small, conical and wide-set in outer row, 3–5 inner rows of smaller close-set teeth, rows tapering laterally to 1 row; body robust, body depth at anal origin 19–22% SL. 1st dorsal-fin origin above and just behind pelvic-fin insertion; 2nd dorsal-fin origin just behind 1st dorsal fin; anal-fin origin below and just behind 2nd dorsal-fin origin; pelvic-fin origin below pectoral-fin insertion; pectoral-fin margin rounded; caudal fin small, with rounded margin.

Head and body brown, green, or dark grey; lower surface of head often dark grey to black; an irregular diffuse dark brown blotch from eye to middle of jaws, and a vertically elongate blotch below eye; body with 6–8 small dark-brown to black spots on mid-side; dorsal midline often with black blotches above each mid-side spot; a series of white dashes just below mid-side; end of caudal peduncle with a <-shaped mark, extending onto caudal-fin base, sometimes broken into 2–3 separate spots at apices of triangle; females with 1–3 dark-brown vertical bars with white interspaces below 1st dorsal fin; body with scattered mottling, often forming irregularly shaped longitudinal lines; 1st dorsal fin with 2 black irregular oblique bands, with orange interspaces; 2nd dorsal fin with irregular oblique orange to brown stripes; anal fin grey; caudal fin clear to grey; pectorals and pelvic fins clear to white in males; pelvic fins almost black in female; pectoral base with an elongate brown spot dorsally.

Variation. Sex ratios were found to be almost even with 44 males and 55 females. Too few specimens were available from localities other than Tas. for a detailed analysis of variation. However, 2nd dorsal ray counts average slightly higher in southern Tas. Because of the slight differences in southern Tas. material, most of that material is excluded from the type series.

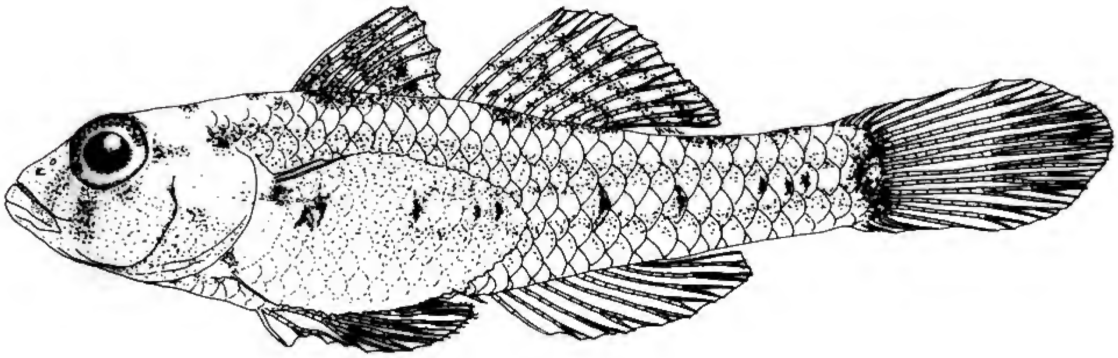

Figure 1. Holotype of *Nesogobius greeni*, AMS I.25944-001, 30.5 mm SL male, drawing by H.K. Larson.

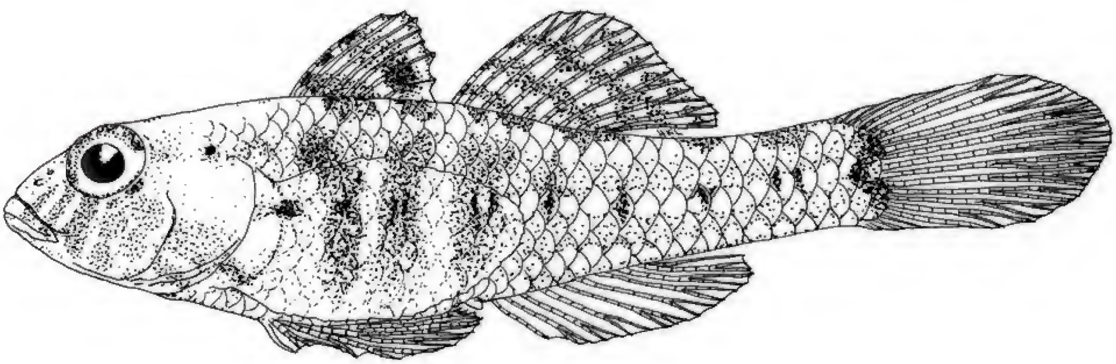

Figure 2. Paratype of *Nesogobius greeni*, AMS I.25944-002, 29.5 mm SL female, drawing by H.K. Larson.

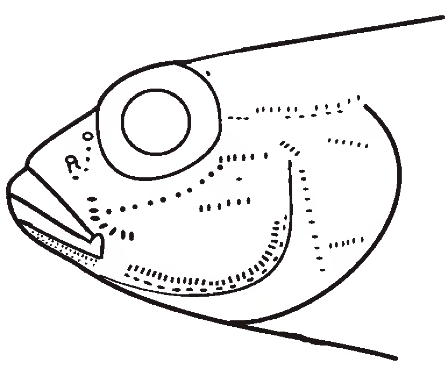

Figure 3. Head of *Nesogobius greeni*, showing papilla pattern, based on several specimens; size of papillae exaggerated, drawing D.F. Hoese.

Table 1. Second dorsal rays in various populations of *Nesogobius greeni*. Asterisk indicates count of holotype.

	8	**9**	**10**
Northern Tasmania	4	40	31
Southern Tasmania	-	4	13
Victoria	1	12	9*
New South Wales	-	1	2
South Australia	-	1	-

Figure 4. Underwater photo of *Nesogobius greeni* from type locality, photo R. Kuiter.

Distribution. *Nesogobius greeni* is known from Merimbula, NSW, throughout Tas., Vic., and east to Kangaroo I., SA. The species is normally found on sand around sea grass beds and around rocky reefs from the intertidal to depths of 8 m.

Etymology. Named for R.H. Green formerly of the Queen Victoria Museum, Launceston, Tas., who collected much of the material used in this study.

Remarks. *Nesogobius greeni* is similar to *Nesogobius pulchellus* in its coloration and deep body. Both species are often collected together at the same station. *Nesogobius greeni* differs from *N. pulchellus* in lacking second dorsal and anal spines (present in *N. pulchellus*), low first dorsal fin subequal in height to second dorsal fin (versus usually higher than second dorsal).

Nesogobius maccullochi sp nov.

Figures 5–7

Gobius hinsbyi - McCulloch and Ogilby, 1919: 215, pl. 33, fig. 1 (in part, including figured specimen).

Nesogobius sp. 1 - Last, Scott and Talbot, 1983: 449, fig. 30.126 (Tas.); Hoese and Larson, 1994: 795, fig. 701 (southern Australia)

Material examined. Holotype AMS I.17575-008, 64 mm SL female, Pinalong Bay, Tas., 6 Dec 1972, D. Hoese and W. Ivantsoff.

Paratypes: Vic.: AMS I.16987-007, 67(28–74), Peterborough, 21 Mar, 1972, D.F. Hoese and W. Congleton; AMS I.16990-002, 4(42–46), Port Phillip Bay, 23 Mar, 1972, D.F. Hoese and W. Congleton; AMS I.22943-001, 5(45–56), Rhyll, Phillip I., B. Rigby, 31 May, 1979; NMV A.3254, 1(48), Bruthen Creek estuary, Gippsland, 6 Aug, 1979, J. Buemer. SA: AMS I.17575-003, 4(50–60), taken with holotype; AMS I.17629-001, 1(38), Salt Creek Bay, south of Coobowie, St. Vincent Gulf, 0–1 m, 23 Dec, 1973, D. Hoese and Party; AMS I.20184-005, 4(35–42), Bay of Shoals, Kangaroo I., 11 Mar, 1978, D. Hoese and B. Russell. Tas.: AMS I.17562-002, 52(19–78), Browns R., Kingston, 0–1 m, 30 Nov, 1972, D. Hoese and W. Ivantsoff; AMS I.17575-003, 6(57–68), inlet 6 km north of Binalong Bay, 0–1 m, 6 Dec, 1972, D. Hoese and W. Ivantsoff; NMV A.3257, 10(28–58), Greens Beach, 8 Jan, 1967, R.H. Green; NTM S.16210-001, 1(47), St. Helens, P. Last; QVM 220, 71(25–68), Kelso, 5 Feb, 1967, R.H. Green; QVM 221, 31(27–47), Greens Beach, 17 Oct, 1965, R.H. Green; QVM 222, 1(28), Greens Beach, 5 Feb, 1967, R.H. Green.

Non-type material: Vic.: AMS I.23456, 13(16–43), Stoney Point, Western Port; NMV A.3553, 1(24), Ricketts Point, Port Phillip Bay, 17 Feb; NMV A.3523, 2(33–35), near Geelong; NMV A.2157, 3(54–65), Portland Harbour; NMV A.3513, 1(40), Rye, Port Phillip Bay; NMV A.3522, 1(47), Rye, Port Phillip Bay; NMV A.3527, 1(48), Crib Point, Western Port; NMV A.3533, 1(51), Hovells Creek, near Geelong, Port Phillip Bay; NMV A.3534, 3(42–50), Crib Point, Western Port; NMV A.3537, 2(38–52), Crib Point, Western Port; NMV A.3538, 2(54–59), Crib Point, Western Port, 3 Sep, 1974; NMV A.3539, 1(38), Crib Point, Western Port; NMV A.3541, 2(37–41), Crib Point, Western Port; NMV A.3542, 3(36–42), Crib Point, Western Port, NMV A.3548, 1(49), 3 km W of Sandringham, Port Phillip Bay, 30 Mar, 1971; NMV A.3552, 1(41), Sorrento, Port Phillip Bay, 31 Jul, 1972. SA: AMS I.20162-027, 1(40), Stokes Bay, Kangaroo I.; AMS I.20177-013, 1(45), American R., Kangaroo I. Tas.: AMS I.14200, 1(69), Wedge Bay, paratype and figured specimen of *Nesogobius hinsbyi*.

Diagnosis. 1st dorsal fin VI–VIII, usually VII; 2nd dorsal-fin rays usually I, 8–9; anal-fin rays usually I, 8, branched caudal-fin rays usually 10; pectoral fin 17–21, rarely 21; an anterior nasal pore medial to and slightly below level of each anterior nostril and a posterior nasal pore by each posterior nostril, a median anterior interorbital pore between front of eyes, a median posterior interorbital pore between end of eyes, an

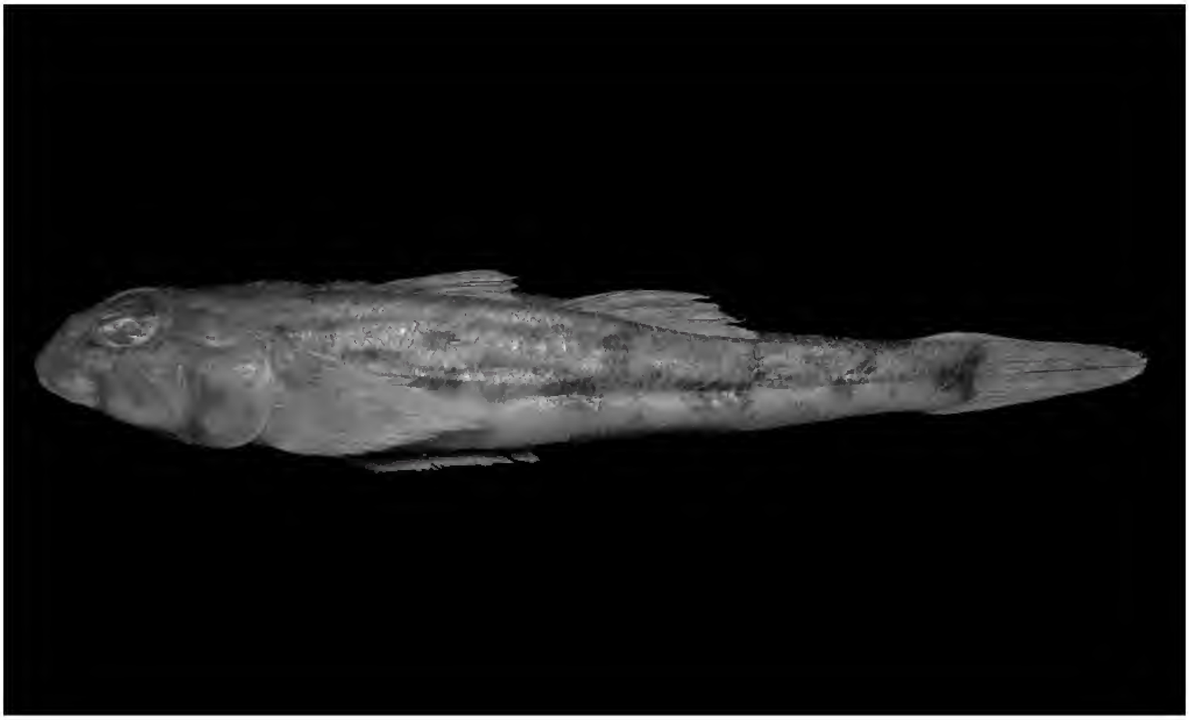

Figure 5. Holotype of *Nesogobius maccullochi*, AMS I.17575-008, 64 mm SL female, photo D. Hoese.

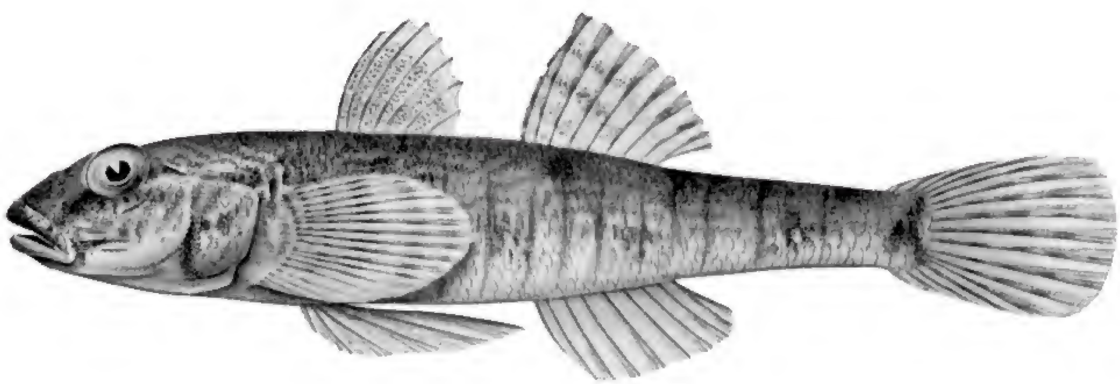

Figure 6. Paratype of *Nesogobius maccullochi* AMS I.14200, 69 mm SL male, Wedge Bay, from McCulloch and Ogilby (1919), image reversed.

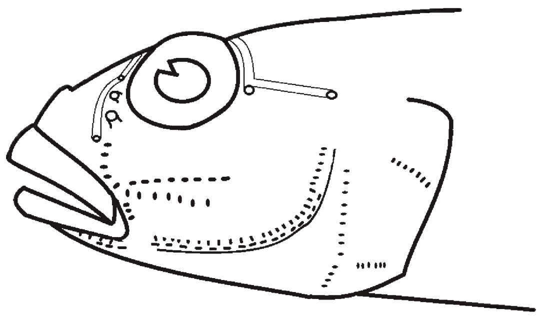

Figure 7. Head of *Nesogobius maccullochi*, showing papilla pattern, based on several specimens; size of papillae exaggerated, drawing by D. Hoese.

infraorbital pore behind each eye and a lateral canal pore along dorsal part of operculum, no preopercular pores; gill opening wide, extending to below posterior preopercular margin; top of head scaled to behind eyes, in 11–18 rows, from 1st dorsal-fin origin; operculum and preoperculum (sometimes absent on preoperculum) with a small patch of scales near dorsal margin, remainder of head without scales; body scales ctenoid, in 37–49 rows; pectoral base and area before pelvic fin scaled (about 15 rows); 1st dorsal fin with rounded or triangular margin.

Description. Based on 109 males and 155 females. 1st dorsal 5(1), 6(8), 7(159*), 8(14); 2nd dorsal rays I,7(3), I,8(93*), 0,9(2), I,9(89), 0,10(2), I,10(3), anal rays, I,7(19), I,8(134*), 0,9(2), I,9(28), 0,10(2), I,10(1); pectoral rays 17(17), 18(71*), 19(62), 20(13), 21(1); predorsal scales 12(1), 13(7), 14(27), 15(31), 16(24), 17 (15), 18(1), 19(1*); segmented caudal rays 12(2), 13(78*); branched caudal rays 9(8), 10(43), 11(1), midline predorsal scales 11(1), 13(4), 14(26*), 15(25), 16(30), 17(9), 18(1), total gill rakers 4(2), 6(5), 7(3), 8(3), 9(3); lower gill rakers on 1st arch 4(9), 5(22), 6(1); lower gill rakers on 2nd arch 4(17), 5(9), 6(4), 7(2); longitudinal scale count 37(1), 38(5), 39(6), 40(7), 41(11), 42(11), 43(8), 44(14), 45(6), 46(6*), 47(4), 48(4), 49(1); TRB 11(6), 12(14), 13(28), 14(18*), 15(4). Head (29–32% SL), broader than deep; mouth small, oblique, forming an angle of 20–25° with body axis, rear end of jaws below front margin of eye; tongue tip rounded; posterior nostril at end of short tube anterior to eye; anterior nostril at end of short tube positioned anteroventrally from posterior nostril, separated from posterior nostril by 2–3 nostril diameters; snout with an elevated bump before eyes, formed by distal tips of ascending process of maxilla; upper lip thick; lower lip thin with shallow free ventral margin anteriorly; chin with a minute round lobe, with sensory papillae from inner preopercular mandibular papilla line meeting sides of lobe; eye large, slightly shorter than snout length; gill rakers on outer face of 1st arch 0–1 + 3–5 = 4–6; rakers short on both faces of all arches, rakers on outer face of 1st arch not larger than rakers on other arches; outer row of teeth in upper jaw enlarged and directed posteriorly, followed by 2 inner rows of smaller teeth tapering laterally to 1 row; outer row of teeth in lower jaw slightly enlarged and curved posteriorly, 1 or 2 inner rows of smaller teeth, tapering laterally to 1 row; body slender, body depth at anal origin 11–13% SL. Body robust anteriorly, slender posteriorly. 1st dorsal-fin origin just behind pelvic-fin insertion, dorsal fin low, subequal to body depth at anal-fin origin; 2nd dorsal-fin origin separated from 1st dorsal fin by 2–3 rows of scales, height of 2nd dorsal fin subequal to 1st dorsal fin; anal-fin origin below and just behind 2nd dorsal-fin origin, anal fin slightly lower than dorsal fins; pelvic-fin origin behind pectoral-fin insertion; pectoral-fin margin rounded; pelvic and pectoral fins subequal in length, slightly shorter than head length; caudal fin short, length slightly shorter than pelvic-fin length, caudal fin with truncate or slightly rounded margin.

Head and body light-grey to brown, often with scattered white and brown flecks; a black bar from eye, extending across middle of jaws; a black vertical bar from eye to just behind rear end of jaws; a vertical bar just behind posterior preopercular margin; mid-sides with 4–6 horizontally elongate dark brown spots; a round black spot at rear end of caudal peduncle, followed by and often connected to a black C-shaped mark at base of caudal fin; mature males with a series of 6–12 vertical dark brown bars on body extending onto belly; bars much thinner than intervening spaces, but variable in width and position; lower operculum, pectoral base, and belly white; dorsal and anal fins with black spots forming more or less horizontal lines; pectoral and caudal fins with small black spots forming wavy vertical bands; pelvic fins white, often with irregular mottling.

Variation. Nesogobius maccullochi shows considerable variation. Males differ considerably in coloration from females. Overall females outnumbered males 1.5 times. However, only two large samples were available to compare ratios and size. One sample from Kelso, Tas. contains 46 females, 21 males and four immature specimens. In a sample from Peterborough, Vic., there are 33 females and 35 males. There was no significant difference in sizes between males and females in either sample. The largest female in all the samples is 78 mm SL and the largest male 70 mm SL. In most samples the largest individual was a female. Comparisons of fin-ray counts from various populations showed no significant differences, but large samples were available from few localities. The second dorsal and anal spine are absent in less than 2% of individuals examined.

Distribution. Tas., Vic., and SA. Normally found on sandy areas in bays and estuaries, from the intertidal to depths of a few metres.

Etymology. The species is named for A.R. McCulloch, formerly Curator of Fishes at the Australian Museum. The name is given not only in recognition of his work, but indicates that this is the species which McCulloch and Ogilby confused under the name *Gobius hinsbyi.*

Remarks. This species is the most abundant species in the genus in shallow areas in southern waters. It has typically been misidentified as *Nesogobius hinsbyi*. The species differs from *Nesogobius hinsbyi* in having head pores (absent in *N. hinsbyi*), opercular scales dorsally only (versus operculum completely scaled), normally with seven dorsal spines (versus usually eight) and second dorsal-fin rays usually I,8–9 (versus I,9–10). *Nesogobius hinsbyi* occurs in deeper water and is generally taken by dredge and trawl. It should be noted that both species were included in material used for the description of *Gobius hinsbyi* in McCulloch and Ogilby (1919). The name originated from a Johnston manuscript, where it was not described and was a *nomen nudum*. That paper was later published by Whitley (1929). The species was described by McCulloch and Ogilby (1919), based largely on one specimen (AMS I.14200), which is figured here as *Nesogobius maccullochi*. McCulloch and Ogilby (1919) mention the Tasmanian Museum specimen as the type and give a brief description of the specimen and indicate that they believed it to be identical to the described specimen. It is regarded here that the use of the wording "the type" clearly indicates that the holotype is the specimen in the Tasmanian Museum. Eschmeyer (1998) listed the specimen as a lectotype, indicating that he believed the figured specimens should have been designated the lectotype. Whether the Tasmanian Museum specimen is a lectotype or holotype does not affect the identity of the species because literature references to "the type" and to the lectotype refer to the same specimen.

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Description of a new species of dwarf *Philypnodon* (Teleostei: Gobioidei: Eleotridae) from south-eastern Australia

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Abstract

Hoese D.F. and Reader S. 2006. Description of a new species of dwarf *Philypnodon* (Teleostei: Gobioidei: Eleotridae) from south-eastern Australia. *Memoirs of Museum Victoria* 63(1): 15–19.

The present paper describes a single species from the coastal drainages in the Coffs Harbour area of New South Wales. The species differs from the only previously described species, *Philypnodon grandiceps*, in having a narrower gill opening (ending under posterior preopercular margin versus under eye), more vertebrae (30–32 versus 29–30), smaller size (maximum size 60 mm SL versus 90 mm SL) and in coloration, particularly lacking the thin vertical bands on sides of the belly characteristic of *Philypnodon grandiceps*. The new species occurs in freshwater and estuarine localities in south-eastern Australia, often occuring with *Philypnodon grandiceps*.

Keywords Fish, Gobioidei, Eleotridae, gudgeon, *Philypnodon*, new species

Introduction

We follow Nelson (2006) here in recognising the family Eleotridae as distinct from the Gobiidae. Hoese and Gill (1993) recognised two subfamilies, the Butinae and the Eleotridinae, placing them as subfamilies of the Gobiidae. Currently 18 described genera and 40 described species of eleotrid fishes are known from Australia. Most are found in estuarine environments. A number of genera of eleotrid fishes occurs in freshwaters of Australia. Some genera, such as *Bunaka* Herre, *Eleotris* Bloch and Schneider, *Giuris* Sauvage and *Ophiocara* Gill are found in estuaries and freshwaters, although often in the lower reaches of rivers. Other genera are largely confined as adults to freshwater. This group includes *Gobiomorphus* Gill, some species of *Eleotris*, most species of *Hypseleotris* Gill, *Kimberleyeleotris* Hoese and Allen, *Milyeringa* Whitley, *Mogurnda* Gill, *Oxyeleotris* Bleeker and *Philypnodon* Bleeker. *Philypnodon* and *Hypseleotris compressa* (Krefft) occur in both freshwater and estuarine environments as adults.

Philypnodon was long thought to be monotypic, with *Philypnodon grandiceps* found in temperate coastal and inland streams from south-eastern Australia. Hoese, Larson and Llewellyn (1980) first noted that a dwarf species of *Philypnodon* was found in southern Australia. Extensive collecting efforts in recent years has yielded considerable material. Studies of that material are revealing a high degree of variability both within and between samples. Because of the high variability in the dwarf forms, it was previously uncertain how many species existed in the genus. The present paper describes a single species from the coastal drainages in the Coffs Harbour area of New South Wales in order to fix a single form for future comparison. A more detailed discussion of geographical variation and description of the other species will be treated in a separate revision.

Methods

Counts and measurements follow Hoese and Allen (1987). Institution abbreviations follow Leviton et al. (1985). The longitudinal scale count was taken from behind the pectoral base to the end of the caudal peduncle and is a count of scale rows, rather than a straight line count. The transverse scale count (TRDB) is taken from the second dorsal origin downward and backward to the anal base. In descriptions an asterisk indicates count of holotype. Measurements were taken on the holotype and the ten best preserved paratypes and are expressed as percent standard length. In the description the first length given is for the holotype followed by the range for the paratypes in parentheses. In lists of material examined the registration number is given, followed by the number of specimens, then the size range of the specimens in parentheses.

Philypnodon Bleeker

Philypnodon Bleeker, 1874: 301, (type species: *Eleotris nudiceps* Castelnau, 1872, by original designation), Syntypes MNHN 1509.

Gymnobutis Bleeker, 1874: 304 (type species: *Eleotris gymnocephalus* Steindachner, 1866, by original designation and monotypy), Syntypes NMW 22519

Ophiorrhinus, Ogilby, 1897: 745 (type species: *Eleotris grandiceps* Krefft, 1864, by original designation) Syntypes BMNH 1864.7.22.40-44; AMS I.2671-2672.

The genus is distinctive in the following combination of characters: no head pores; no scales on cheek or operculum; nape naked to fully scaled; body fully scaled, largely with ctenoid scales; midline of belly sometimes without scales; anterior nostril at end of short tube above and almost in contact with middle of upper lip, posterior nostril with raised rim slightly in front of anterior margin of eye; usually seven dorsal spines; first dorsal-fin origin well posterior to pectoral-fin insertion; pelvic-fin origin well posterior to pectoral-fin insertion to almost below pectoral-fin origin; transverse papilla pattern; large mouth, longer in males than females; bulbous cheeks in adults; wide gill opening extending to below eye or preoperculum; 15 segmented caudal rays; vertebrae 29–32; an interneural gap between neural arches after the first dorsal fin and before the second dorsal fin, without a pterygiophore; vomer and palatine without teeth. The genus is easily distinguished from other eleotridine Australian genera by the combination of seven dorsal spines and transverse papilla pattern.

The genus *Philypnodon* was placed within the subfamily Eleotrinae of the Gobiidae by Hoese and Gill (1993), but did not treat relationships within the subfamily. Thacker and Hardman (2005) suggested a close relationship of *Philypnodon* with the New World genera *Microphilypnus* and *Leptophilypnus*, based on molecular studies. Both genera have features in common with *Philypnodon* including an interneural gap (a space between neural arches after the first dorsal fin and before the second dorsal fin without a pterygiophore; a derived feature within the Eleotrinae) and a transverse papilla pattern, a combination found only in these genera and in *Thalasseleotris* in the Eleotrinae (Hoese and Gill, 1993).

The genus is confined to the freshwaters and estuaries of south-eastern Australia from the Burnett R. in Queensland to South Australia and from scattered localities in the Murray-Darling River system in New South Wales and South Australia.

Philypnodon macrostomus sp. nov.

Figures 1-3

Philypnodon sp: Hoese, Larson and Llewellyn, 1980: 171, fig. 31.3
Philypnodon sp. 1: Merrick and Schmida, 1984: 306, fig. 256
Philypnodon sp: Hoese and Larson, 1994: 810, fig. 715
Philypnodon species: Allen, Midgley and Allen, 2002: 317

Material examined. Holotype AMS I.20111-002, 36.5 mm SL male, creek 8 km from Glenreagh, N of Coffs Harbour, NSW, 5 May 1977, D. Hoese and J. Bell. Paratypes: AMS I.20111-016, 31(25–41), taken with holotype; AMS I.20111-003, 3(28–36), cleared and stained and-004, 4(39–40), cleared and stained, taken with holotype; AMS I.29683-008, 1(33), Karinga Creek W of Coffs Harbour, NSW, 19 Aug 1977, D. Hoese and R. McDowall; AMS I.33875-001, 1(38), Dingo Creek, 27 km W of Coffs Harbour, 5 May 1977, D. Hoese and J. Bell; NMV A.29399-001, 4(21–36), taken with holotype; NTM S.16213-001, 3(31–39), taken with holotype; QM I.37768, 3(30–31), taken with holotype.

Diagnosis. Gill opening wide, extending anteroventral to preoperculum, but not reaching to below eye, usually ending below posterior preopercular margin, sometimes as far forward as midway between posterior preopercular margin and eye. Head papillae in transverse pattern (figs 2–3). Body generally dark brown, with darker brown mottling on sides; 1st dorsal with black stripes in adult males. Jaws reaching to behind eye in mature males, variably developed in juvenile males and females, usually reaching below middle of eye to near end of eye. Tongue tip rounded to truncate.

Description. An asterisk indicates count of holotype. 1st dorsal fin VI (in 8*), VII (23), VIII (4); 2nd dorsal-fin rays I,8 (8), I,9 (21*), I,10 (5); anal-fin rays I,8 (10), I,9 (22*), I,10 (3); pectoral rays 15 (4), 16 (21*), 17 (9). 18 (1) segmented caudal rays 8/7 (12), 8/8 (1*); branched caudal rays 7/6 (12*), 7/7 (1); procurrent caudal rays 9/8 (1), 9/9 (1), 10/8 (1), 10/10 (1), 11/10 (3); predorsal scale count 4(1), 5(1), 7(1), 8 (3), 9 (2), 10 (1), 11 (6), 12 (2), 13 (6), 14 (6*), 15 (1); longitudinal scale count 34 (5), 35 (6*), 36 (6), 37 (10), 38 (5), 39 (1), 42 (1); transverse scale count (TRDB) 9 (16*), 10 (12), 11 (7); gill rakers on outer face of 1st arch 2+1+8 (7), 3+1+8 (1), 2+1+9 (22), 2+1+10 (2); lower rakers on outer face of 2nd arch 7 (9), 8 (22), 9 (3); vertebrae 12+19 (3), 13+18 (2), 13+19 (2).

Head distinctly depressed, flat on top, length 29.5% SL in holotype (range 29.5–33.6% SL); eyes dorso-lateral, 6.8% SL (6.4–7.4% SL), interorbital wide, slightly less than eye diameter in juveniles to about 1.5 times eye diameter in adult; snout short, about equal to eye diameter, 8.1% SL (7.8–9.2% SL); cheeks distinctly bulbous in adult males; mouth slightly oblique forming an angle of about 35–45° with body axis; posterior margin of jaws below mid-eye in females, to below or just beyond posterior end of eye in males, length of upper jaw 15.4% SL (13.7–18.7% SL) in males and 10.2–14.8% SL in females; teeth in both jaws small and curved, anteriorly in 2 or rarely 3 rows, tapering laterally to a single row; posterior nostril with raised rim, approximately 1 nostril diameter in front of eye in a horizontal line between mid-eye to upper pupil margin; anterior nostril at end of short tube, just behind middle of upper lip, in a horizontal line between mid-eye to lower margin of pupil; gill rakers slender, much shorter than filament length on outer face of 1st arch, longest rakers near angle of arch about one-quarter length filament length; rakers on inner face of 1st arch and following arches short and denticulate.

Body slender, slightly compressed anteriorly, becoming very slender posteriorly; depth at pelvic-fin origin 14.6% SL (14.5–18.8% SL); depth at anal-fin origin 14.1% SL (13.1–17.7); caudal peduncle slender and elongate, length 29.8% SL (24.1–30% SL), least depth 9.2% SL (8.2–10.5% SL).

Head naked; predorsal partly scaled, midline scaled to above posterior preopercular margin to midway between posterior preopercular margin and eye (just before posterior preopercular margin in holotype), often naked in specimens less than 15 mm SL; scales on side of nape variable, sometimes with scales as far forward as midline scales (in holotype), but often reduced,

Figure 1. Holotype of *Philypnodon macrostomus*, AMS I.20111-002, 36.5 mm SL male.

sometimes naked forward of pectoral-fin base. Body scales ctenoid; body fully covered with scales, becoming cycloid above a line from upper gill attachment to below posterior quarter of 1st dorsal fin; belly covered with small cycloid scales, midline naked in specimens with reduced predorsal scales, pectoral-fin base normally covered with small scales, naked in specimens with reduced predorsal scales, prepelvic area covered with small cycloid scales, except for a triangular area behind gill opening to fully naked in specimens with reduced predorsal scales.

1st dorsal fin low, with rounded margin, fin reaching to or just short of 2nd dorsal fin when depressed; 1st dorsal spine slightly shorter than 2nd spine, 2nd to 4th spines subequal in length, 5th spine subequal in length to 1st spine; 6th spine slightly shorter than 5th spine, 7th spine shorter than 6th spine; 2nd dorsal fin separated from 1st dorsal fin, fin elevated, slightly higher than 1st dorsal fin, subequal to body depth, 1st segmented ray usually branched, other rays always branched; anal fin origin below and slightly behind 2nd dorsal-fin origin, usually below 2nd segmented dorsal ray, fin subequal in height to 2nd dorsal fin, 1st segmented rays usually branched, other rays branched; pelvic fins completely separate, pelvic fin short, reaching approximately half distance from pelvic-fin origin to anal-fin origin, length 18.4% SL (14.1–18.4% SL), pelvic-fin rays I,5, all segmented rays branched, rarely innermost ray unbranched; pectoral fin with broadly rounded margin, reaching to above or slightly before anus, length 22.8% SL (19.6–24.2% SL), pectoral rays branched, upper and lowermost sometimes unbranched; caudal fin with rounded posterior margin, caudal length 17.9% SL (17.0–25.1% SL).

Urogenital papilla of male flattened dorso-ventrally, with small lobes laterally; papilla of female broad and rounded, with an indentation posteroventrally.

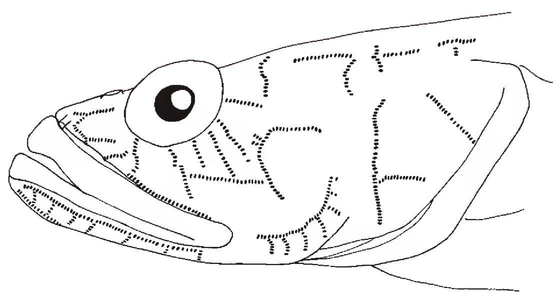

Figure 2. Lateral view of head showing sensory papillae, largely based on holotype, drawing by S. Reader.

Sensory papillae. Transverse papillate pattern; all papilla lines with papillae at right angle to axis of line. Sides of head with 6 lines radiating from eye; preopercular mandibular series with 10–14 transverse lines from chin to middle of preoperculum. Other papillae as shown in figs 2 and 3.

Coloration of freshly collected specimens. (holotype and male paratype). Head and body dark brown, lighter brown to pale orange ventrally. Lips dark brown with diffuse orange pigment on posterior half; 2 dark-brown stripes extending postero-ventrally from posteroventral margin of eye onto cheeks, not reaching posterior preopercular margin; a large light-brown oval area behind tips of dark stripes; an irregularly shaped light-brown stripe extending from below eye posteroventrally to just

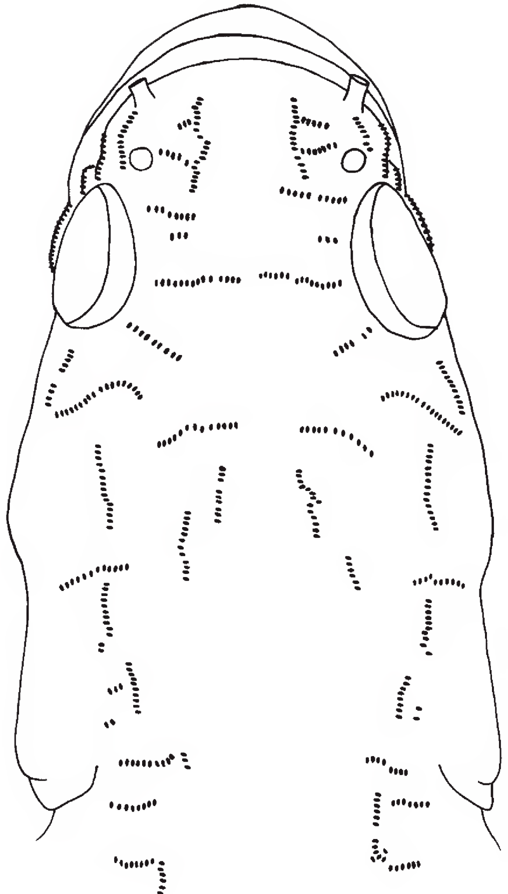

Figure 3. Dorsal view of head showing sensory papillae, largely based on holotype, drawing by S. Reader.

above posterior end of jaws; operculum with light-brown almost horizontal stripe in line with interspace between dark stripes extending from eye; a similar light-brown stripe dorsally on operculum; rest of operculum dark brown; body scales edged in dusky-brown pigment, dorsally broadly edged with dark-brown pigment, scale centres often with light thin vertical line; series of 2–3 small black spots above pectoral-fin base; pectoral-fin base black dorsally followed by white irregular bar extending full length of pectoral-fin base; caudal peduncle with dark-brown vertical bar, with a short anterior extension. Dorsal fin with 2 black curved stripes following contour of fin; distal margin of dorsal fin with broad orange band, followed by black stripe curving to meet body, followed ventrally by a lighter orange to brown stripe, followed ventrally by 2nd black stripe; anteriorly white blotches below stripe; 2nd dorsal fin with black distal margin (about one-quarter of fin), followed ventrally by 4 curved, oblique stripes, with orange to white interspaces. Anal fin with scattered melanophores giving fin a gray appearance; base of fin lighter, followed distally by pale black stripe followed by lighter stripe, followed by dark gray stripe, distal tip lighter than rest of fin. Pectoral and pelvic fins white to dusky. Caudal fin pale orange basally, becoming dark gray posteriorly; series of 2–4 curved dark bands, extending across all, but uppermost 1 or 2 and lowermost 1 or 2 segmented caudal rays, each band formed from 2–3 rows of small black spots on fin rays, generally no spots on membranes between rays.

Coloration in alcohol. Head and body light brown, paler ventrally, males generally darker than females. 2 faint brown stripes extending posteroventrally from posteroventral margin of eye onto cheeks, not reaching posterior preopercular margin; distinct light-brown areas and stripes on head present in fresh material not visible; operculum light brown; body scales edged in light-brown pigment, dorsally broadly edged with dark-brown pigment; large black spot above pectoral-fin base with pale areas; black spot dorsally on pectoral-fin base, a thin brown band extending from spot ventrally covering pectoral-fin base, no pale band visible; large dark-brown area at posterior end of caudal peduncle forming a vertical band, a vertical band with a horizontal extension, or triangular mark. Dorsal fin with 2 black curved stripes following contour of fin as in fresh material, orange and white areas in fresh material becoming light brown; 2nd dorsal fin with black to gray distal margin (about one-quarter of fin), followed ventrally by 4 curved, oblique dark stripes, with light-brown interspaces. Anal fin with scattered melanophores giving fin a uniform gray appearance. Pectoral and pelvic fins clear, without pigment. Caudal fin pale light-brown to gray, with series of 2–4 curved dark bands, extending across all but uppermost 1 or 2 and lowermost 1 or 2 segmented caudal rays, each band formed by 2–3 rows of small dark brown spots on fin ray, generally no spots on membranes between rays.

Distribution. Philypnodon macrostomus is widely distributed in coastal rivers from Brisbane, Qld, throughout NSW, Vic. and eastern SA in freshwater and in brackish to full strength seawater in upper reaches of estuaries. It is also found in the Lower Murray R. system from scattered localities. The related *Philypnodon grandiceps* occurs north to the Burdekin R., Qld. Specimens of the dwarf species from the Mary R. north of Brisbane are currently under study, but do not appear to be conspecific and will be reported on later in a revision of the genus. Similarly, specimens from the Cudgegong R. in Macquarie R. drainage in central NSW lack predorsal scales and possibly represent a separate species to be treated in the revision.

Etymology. from the Latin *macro* = large and *stomus* = mouth, alluding to the large mouth that develops in males.

Remarks. Philypnodon macrostomus differs from *Philypnodon grandiceps* in having a narrower gill opening (below posterior preopercular margin versus below eye in *P. grandiceps*); sides of belly without vertical bands (versus 4–5 thin brown almost vertical lines); tongue tip rounded to truncate (versus bilobed); body often mottled (versus body uniformly coloured) and having more numerous vertebrae (usually 31–32, versus usually

29–30). The species also reaches a much smaller size, usually less than 50 mm SL, with the largest specimen known 60 mm SL (versus commonly reaching a size of 70 mm SL and reaching a maximum size of almost 90 mm SL).

While the species is widely distributed, it shows considerable variation over the range of the species. The intensity of coloration varies from light brown to almost black. Fin ray counts vary considerably, but without any clear geographical pattern. More detailed analysis of geographical variation will be presented in a revision by the authors at a later time.

The differences in the urogenital papilla were minor in comparison with other gobioid fishes and it was difficult to sex the species. Poor preservation can result in distortion of the papilla.

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Description of a new species of *Heteroclinus* (Blennoidei: Clinidae) from southern Australia

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Abstract Hoese, D.F. and D. S. Rennis 2006. Descriptions of a new species of *Heteroclinus* (Blennoidei: Clinidae) from southern Australia. *Memoirs of Museum Victoria* 63(1): 21–24.

A new species of *Heteroclinus* is described from Victoria, South Australia and Western Australia. The species is distinctive from other Australian clinids in having two well-developed segmented pelvic rays, first dorsal fin on head originating just behind or at posterior end of eye, a reduced lateral line and in fin-ray counts.

Keywords Fish, Blennioidei, Clinidae, Heteroclinus, new species

Introduction

Clinid fishes represent one of the most speciose groups of fishes from southern waters of Australia. Over 35 species are known, with only three extending to the tropics or southern parts of the tropics. George and Springer (1980) reviewed the species of the tribe Ophiclinini. Hoese (1976) described one new species of *Heteroclinus* and reviewed the historical studies of clinid fishes of Australia. Rennis et al. (1994) placed the temperate species of the tribe Clinini into the genera *Heteroclinus* and *Cristiceps*. The description provided here forms part of a revision of the remaining clinid fishes of Australia and contrasts all the species in the *Heteroclinus adelaidae* complex.

Currently three genera of the tribe Clinini are known from Australia: *Springeratus,* with a single species, *Cristiceps* with three and *Heteroclinus* with 25 species. Further studies on the relationships within the group may alter the generic classification. One species (*Heteroclinus flavescens* found in southern Australia and New Zealand) has been regarded as belonging to the separate genus *Cologrammus.* More detailed information on relationships will be included in our revision of the genus *Heteroclinus.*

Methods

Counts and measurements largely follow those given by Hubbs and Lagler (1958). The last anal ray and last dorsal ray are separate, not branched and are counted as separate rays. In lists of material examined, institution abbreviations follow Leviton et al. (1985). The number of specimens is given following the registration number and the size range in mm, standard length is given in parentheses. The dorsal-fin ray count is partitioned into three parts, anterior first dorsal fin (separate, or connected basally to the second dorsal fin), second dorsal spines and dorsal segmented rays (part of second dorsal fin). Circumorbital pore count includes pores in contact with or immediately adjacent to the eye and includes all pores in the infraorbital series.

Heteroclinus Castelnau, 1872

Heteroclinus adelaidae complex

Members of the *Heteroclinus adelaidae* complex, which includes H. *adelaidae, H. macrophthalmus* and the species described below, all have only two developed segmented pelvic rays and the anal fin broadly connected by membrane to about the middle of the caudal peduncle.

Heteroclinus kuiteri, sp. nov.

Figures 1–3

Heteroclinus sp. 1: Rennis, Hoese & Gomon, 1994: 746, fig. 652 (southern Australia); Hutchins, 2005 (Western Australia)

Heteroclinus species 2: Hutchins, 1994: (Western Australia)

Material examined. **Holotype**: AMS I.19777-009, a 44 mm SL male, Portsea Pier, Port Phillip Bay, Vic., R. Kuiter, 12 Apr, 1977. **Paratypes**. Vic.: AMS I.19921-009, 1(41), Port Phillip Bay, R. Kuiter, 30 Jul, 1977; AMS I.19775-002, 1(42), Portsea, Port Phillip Bay, R. Kuiter, AMS I.19776-005, 3(46–49), Flinders Pier, R. Kuiter, 13 Apr, 1977;

Figure 1. Holotype of *Heteroclinus kuiteri* AMS I.19777-009, a 44 mm SL male. Photo is of the right side and reversed to better show the fins (tip of dorsal fin hidden on left side) and allow comparison with other specimens, photographed several years after collection.

Figure 2. Male paratype of *Heteroclinus kuiteri*, AMS I.19777-006, 39 mm SL male, photographed a few weeks after collection.

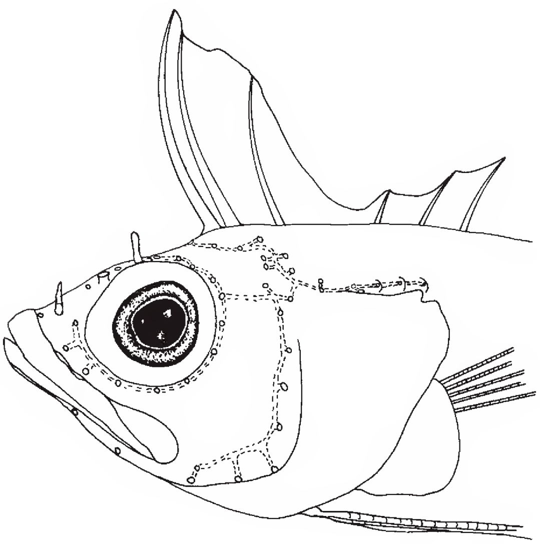

Figure 3. Head of *Heteroclinus kuiteri*, composite based on holotype and paratypes showing distribution of head pores. Note that only the upper 5 pectoral rays shown.

AMS I.19777-006, 3(34–38), collected with holotype; AMS I.24050-001, 2(47–60), Port Phillip Bay, R. Kuiter, 1981; AMS I.24051-001, 1(58), Port Phillip Bay, R. Kuiter, 1981; AMS I.24218-001, 4(39–53), Port Phillip Bay, R. Kuiter, 6–9 Jun, 1976; NMV A.2603, 1(41), Refuge Cove, 5 m, G. Poore & H. Lew-Ton, 9 Feb, 1982; NMV A.2604, 1(35), south headland, Refuge Cove, 5 m, G. Poore & H. Lew-Ton, 10 Feb, 1983; NMV A.2606, 2(41–44), south headland, Refuge Cove, 13 m, C. Larsen, T. Cochran and R. Wilson, 10 Feb, 1982; NMV A.2607, 1(42), south headland, Refuge Cove, 13 m, C. Larsen, T. Cochran & R. Wilson, 10 Feb, 1982; NMV A.2608, 1(48), south headland, Refuge Cove, 13 m, C. Larsen, T. Cochran & R. Wilson, 10 Feb, 1982; NMV A.3577, 1(45), Portsea, Port Phillip Bay, 5 m, B. Ruffle, 12 Mar, 1984; NMV A.3579, 1(36), off Stony Point, Western Port Bay, 16 m, Fisheries and Wildlife Department "Caprella", 1 Jun, 1967; ZMUC (uncatalogued), 4(44–52), Western Port, T. Mortensen, 6 Sep, 1914. SA NMV A.498, 1(64), Port Lincoln, J. Veitsch, 16 Dec, 1968 WA: WAM P.25767-010, 3(38–47), Sandy Hook I., Recherche Archipelago, J.B. Hutchins, 10 Apr, 1977; WAM P.26599-004, 4(34–48), Cosy Corner (34°15'S, 115°01'E), J.B. Hutchins, 11 Apr, 1980.

Diagnosis. Dorsal fins III, XXIX–XXXI, 2–4 (usually 3); anal II, 21–24 (usually 22–23); segmented caudal rays 10–11 (usually 11); pectoral rays 12–13 (usually 12); pelvic rays I, 2 (sometimes with basal element of a rudimentary 3rd ray only visible on dissection); gill rakers on outer face of 1st arch, 1–2+5–7=6–9 (usually 7–8). Lateral line composed of an arched section above pectoral fin curving to midline behind pectoral fin and continuing horizontally along midline of body; posterior straight portion of lateral line reduced, lateral line scales not extending beyond middle of anal fin; anteriormost lateral line scales from end of head to above middle of pectoral fin overlapping with a single median posterior pore, posteriorly lateral line scales separate with a median pore at each end. Circumorbital pores uniserial (12–17 pores). Orbital tentacle short (1.3–4% SL), with rounded margin, sometimes with minute lateral lobes. Nasal tentacle elongate, spoon-shaped. 1st dorsal fin elevated, higher than 2nd dorsal fin; 2nd dorsal spine usually longest (6.1–13.9% SL, in females, 12.6–16% SL, in males), 1st spine rarely the longest; 1st dorsal fin originating over or just before posterior margin of eye, posterior end of fin connected by membrane to basal one-quarter to half of 2nd dorsal fin. Pterygiophores from 1st dorsal fin in groove on skull. All dorsal spines followed by fleshy flaps bound in interspinal membrane extending from tips of spines. Last dorsal rays evenly spaced, membrane from last ray connected to upper base of caudal fin at end of caudal peduncle. Last anal ray broadly connected by membrane to just beyond middle of caudal peduncle. Pelvic rays thin (a 3rd rudimentary ray sometimes present, visible only on dissection), 2nd ray reaching to about the anus. Gill rakers on outer face of 1st arch short and pointed. Body slender to moderate (depth at anal origin 16.2–20.3% SL). Often with broad dark stripe on midside.

Description. 1st dorsal III (34*); 2nd dorsal-fin spines XXIX(6), XXX(17), XXXI(10*), segmented dorsal rays 2(4), 3(27*), 4(3); anal fin-rays II, 21(1), II, 22(13*), II, 23(18), II, 24(2); pectoral fin-rays 12(30*), 13(4); pelvic rays I, 2(34*); segmented caudal rays 10(2); 11(31*) vertebrae 14+28(6), 14+29(7), 14+30(1), 15+29(1). Circumorbital pores 12(1), 13(5), 14(9*), 15(7), 16(1), 18(1); total gill rakers on outer face of 1st arch 6(4), 7(6), 8(15*), 9(2); lower gill rakers on outer face of 1st arch 5(7), 6(18*), 7(2). Pored lateral-line scales 19–25 (arched portion of line) + 0–15 (straight portion of line); anterior lateral line scales 19(4), 20(3), 21(4), 22(8), 23(1)1, 24(3*), 25(4); posterior lateral line scales 0(2), 2(2*), 3(2), 4(3), 5(1), 6(1) 7(2), 8(1), 9(1), 10(3), 11(2), 12(4), 13(1), 14(2), 15(1); branchiostegal rays 6(14*). Vomer with single row of teeth forming a V; palatine without teeth.

Head compressed, moderate to large (27.2–30.4% SL, 34-37 mm, 23.2–27.7% SL, 38–61 mm); snout obtusely pointed, snout less than eye diameter, (3.6–6.3% SL), eye (6.9–9.7% SL), interorbital narrow, about half to three-quarters eye diameter; mouth short, jaws reaching to below middle of eye, upper jaw length, 9.3–13.2% SL; anterior nostril tubular with simple nasal tentacle; posterior nostril with elevated rim at anterodorsal margin of eye; gill rakers very short and simple; rakers on 2nd and following arches moderately developed; tongue tip broadly rounded; upper jaw with outer row of conical teeth, slightly enlarged extending to near end of premaxilla; anteriorly 3–4 inner rows of smaller conical teeth tapering laterally to 1 row, ending around middle of premaxilla; lower jaw with outer row of conical teeth enlarged covering all of dentary; 2 or 3 inner rows of smaller teeth tapering laterally to a single row ending before middle of dentary; intromittent organ elongate, pointed and curved forward as in *Heteroclinus macrophthalmus* figured by Hoese (1976).

Head pores as shown in fig. 3, circumorbital and preopercular pores uniserial.

Head largely naked, body scales small and cycloid extending forward to above operculum below end of 1st dorsal fin; scales overlapping and forming distinct rows anteriorly, becoming nonimbricate and irregular posteriorly.

1st dorsal fin elevated, about twice height of 2nd dorsal in males and slightly higher than 2nd dorsal in females; 2nd spine usually longest, with 1st and 2nd spines subequal in height and longer than 3rd spine; membrane from 1st dorsal fin connects to body at base of 2nd dorsal fin; 2nd dorsal origin above a point before pectoral origin and behind pelvic insertion; 1st spine of 2nd dorsal short, spines becoming progressively longer posteriorly, with last spine the longest; dorsal segmented rays evenly spaced; anal origin below 11th or 12th spine of 2nd dorsal fin, anal spines short, anal segmented rays longer and becoming progressively longer posteriorly; caudal fin with rounded margin (16.3–19.2% SL); pectoral fin with rounded margin, rays unbranched, central rays longest, reaching to above or just behind anus; pelvic fins with hidden spine, 2 developed rays and usually a 3rd rudimentary ray visible only on dissection.

Coloration of freshly collected material. (Based on colour photos provided by R. Kuiter from Vic. and B. Hutchins from WA). Colour variable. Sometimes with head, tail, and dorsal portion of trunk dark with a brown and white mottled midlateral band extending posteriorly from eye across upper half of preoperculum and operculum, along trunk, and breaking into oblong patches on tail; females and some males brown with 8 dark-brown irregularly shaped vertical bars across trunk and tail extending onto dorsal and anal fins, bars often broken forming irregular saddle-shaped spots, those along back darkest; some males and females with body uniform brown or lightly mottled; 1st dorsal fin black; females with 1st spine sometimes banded; caudal and ventral fins pale, usually with a series of red spots forming transverse bands; snout and edges of interorbital frequently white; lower half of head with large black spots, large dark spot often present basally on pectoral rays 8–10; females with belly, ventral portions of tail and midlateral portions of trunk and tail sometimes with white spots.

Coloration in alcohol. Similar to fresh coloration, except that pigment less intense and red becoming pale brown.

Distribution. The species is known from Vic., Port Lincoln, SA and Cosy Corner, near Albany and Sandy Hook I. off Esperance, WA. It is associated with rocks and algae in shallow water from depths of 5–13 m.

Etymology. Named for Rudie Kuiter, who provided much of the type material and valuable material of other Australian clinids.

Remarks. One sample from Western Port, Victoria (ZMUC) is unusual in that one specimen has 13-13 pectoral rays, two have 12-13 and one has 12-12. Only one other specimen was found with 13 pectoral rays.

Heteroclinus kuiteri is most similar to *H. adelaidae* Castelnau and *H. macrophthalmus* Hoese, in having the last anal ray broadly connected by a membrane to the caudal peduncle, two slender and elongate pelvic rays and often a rudimentary third pelvic ray, visible only upon dissection. *Heteroclinus kuiteri* differs from *H. macrophthalmus* in lacking free filaments extending off the first few dorsal spines (free and branched in *H. macrophthalmus*), simple orbital tentacle (versus tentacle branched with five lobes) and fewer dorsal rays (two–four, versus usually five). *Heteroclinus kuiteri* differs from *H. adelaidae* in having more numerous pectoral rays 12–13 (versus 11), dorsal fin origin over or before posterior margin of eye (versus over posterior preopercular margin), with pterygiophores in groove in skull (versus pterygiophores behind skull) and no black line along anterior lateral line (versus usually present).

Acknowledgements

We thank Gregory Millen for the photograph of the paratype. Photos and material of this species were provided by R. Kuiter and B. Hutchins. We thank B. Hutchins and M. Gomon for loan of material.

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Description of two new species of shore-eels (Gobiesocidae: Cheilobranchinae: *Alabes*) from south-eastern Australia and Norfolk Island

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Abstract Hutchins, B. 2006. Description of two new species of shore-eels (Gobiesocidae: Cheilobranchinae: *Alabes*) from south-eastern Australia and Norfolk Island. *Memoirs of Museum Victoria* 63(1): 25–28.

Two new species of *Alabes* are reported, one from Tasmania and the other from Norfolk Island. The first is similar in general appearance to *A. parvula*, but is considerably smaller in size (to 39 mm SL) and inhabits waters of much greater depth (160–348 m). The Norfolk Island species has a uniquely enlarged buccal region and is possibly endemic to this island.

Keywords *Alabes*, Cheilobranchinae, Tasmania and Norfolk Island, Australia

Introduction

Following a study of the Australian subfamily Cheilobranchidae, Hutchins and Morrison, 2004 described five new species of *Alabes,* namely *A. elongatus, A. gibbosus, A. obtusirostris, A. occidentalis and A. scotti*. They also recognised four previously described species, *Alabes dorsalis* Richardson, *A. parvula* McCulloch, *A. hoesei* Springer and Fraser, and *A. brevis* Springer and Fraser, concurring with the findings of an earlier review (Springer and Fraser, 1976). The latter review also reported a single Norfolk Island specimen of doubtful identity but close to *A. parvula*, and indicated that further specimens should be collected before its status could be verified. As no new material of the Norfolk Island form had been forthcoming in the intervening years, Hutchins and Morrison, 2004 preferred not to provide a description, but did include it, as *Alabes* sp., in a table to the genus indicating its unique identity. Furthermore, they also examined, but did not report on, two specimens of a form similar to *Alabes dorsalis* which had been collected offshore from Tasmania at a depth of 160 m (*A. dorsalis* is a common intertidal species which occurs rarely to a maximum depth of 30 m). However, the two nondescript specimens were small (29–39 mm SL versus a maximum size of 120 mm for *A. dorsalis*), and were suspected of being juveniles that had possibly been carried offshore by ocean currents. Recently a third specimen of this form was taken at an even greater depth (348 m) near King Island, just to the north-west of Tasmania. It proved to be conspecific with the other two Tasmanian specimens, and although very similar to *A. dorsalis*, all three nevertheless represent an undescribed species. The purposes of the present paper, therefore, are to provide descriptions of these two rare species from Norfolk Island and Tasmania, and to expand the key of Hutchins and Morrison, 2004 to include them.

Methodology follows that of Hutchins and Morrison, 2004. The following abbreviations refer to cephalic pores of the lateral line system: ANP, anterior nasal pore; LP, lacrymal pore; PNP, posterior nasal pore; POP, postocular pore. Standard length is abbreviated SL and head length is abbreviated HL. Type material is held in the Australian Museum, Sydney (AMS), Marine Research Laboratories, CSIRO, Hobart (CSIRO), and Museum Victoria, Melbourne (NMV).

Key to the species of *Alabes*

1. Pelvic fin rudiment present, located on ventral surface immediately behind gill opening 2
– Pelvic fin rudiment absent 6
2. Pelvic fin rudiment moderate in size, fin rays present; POP 1 3
– Pelvic fin rudiment small, pelvic fin rays (if present) not visible; POP 2, usually widely separated 5
3. Pelvic fin rudiment width equal to or wider than length of gill slit 4
– Pelvic fin rudiment less than length of gill slit (Tasmania) .... *A. bathys* sp. nov.
4. Body relatively robust (depth 9.3–11.6 in SL); dorsal fin fold relatively high, continued anteriorly to vertical through urogenital opening (snout to origin of dorsal fin fold 2.0–3.5 in SL); blackish circular blotches often present on middle of side of adult (NSW, Vic., Tas., and SA) .... *A. dorsalis*
– Body more slender (depth 12.5–14.9 in SL); dorsal-fin fold relatively low, origin falling well short of vertical through urogenital opening (snout to origin of dorsal fin fold 1.3–2.4 in SL); no dark circular blotches on side of large adult (WA) .... *A. elongata*

5. Head relatively large, length 6.7–7.6 in SL; PNP absent (WA) .... *A. brevis*
– Head relatively small, length 9.7–11.4 in SL; PNP present (WA) .... *A. gibbosa*
6. Gill slit small, length 5.4–22.9 in HL; POP 1 or 2; nasal pores present or absent 7
– Gill slit moderately large, length 3.1–4.3 in HL; no POP or nasal pores (Tas. and WA) .... *A. obtusirostris*
7. Origin of dorsal-fin fold over vertical through urogenital opening or behind; anal-fin fold prominent, extending about half way from caudal fin to urogenital opening; interorbital relatively wide, width 5.4–10.8 in HL; body translucent posteriorly in life, sides without alternating black and white bars 8
– Origin of dorsal-fin fold just behind head; anal-fin fold absent or restricted to region just anterior to caudal fin; interorbital very narrow, width 8.8–22.6 (usually 15 or more) in HL; body orange in life (not translucent posteriorly), sides with alternating wide black and narrow white bars (NSW, Vic., and Tas.) .... *A. scotti*
8. Postocular pores 1; PNP absent; caudal-fin rays less than 7 or absent 9
– Postocular pores 2; PNP usually present; caudal-fin rays 7–8 (NSW, Vic., Tas., SA, WA) .... *A. hoesei*
9. Origin of dorsal-fin fold over vertical through urogenital opening 10
– Origin of dorsal-fin fold well posterior to vertical through urogenital opening (Norfolk I.) .... *springeri* sp. nov.
10 Lacrymal pores present; male with pattern of regular tiger-like bars anteriorly on side of body, not merging ventrally with longitudinal series of 4 blackish to dark-blue blotches on side of abdomen, area of blotches extending about half way between gill slit and urogenital opening (NSW, Qld) .... *A. parvula*
– Lacrymal pores absent; male with irregular arrangement of tiger-like bars anteriorly on side of body, merging ventrally with 2–3 blackish blotches which extend about one-third distance between gill slit and urogenital opening (WA) .... *A. occidentalis*

Alabes bathys sp. nov.

Figures 1a, b; Table 1

Material examined. Holotype. NMV A14558, 39 mm SL, Tas., 30 km NNW of Cape Sorell (42°10.9'S, 144°48.9'E), WHOI epibenthic sled at 160 m, RS Wilson on board *RV Soela* (field no. S05/84 54), 20 Oct 1984.

Paratypes. NMV A28045-001, 29 mm SL, taken with holotype (disarticulated cleared and stained skeletal material); CSIRO H.6156-01, 38 mm SL, Tas., King I. Canyons, west of King I. (between 39°48'S, 143°08'E and 39°50'S, 143°07'E), Sherman sled at 348 m, FRV *Southern Surveyor* (field no. SS0404/35), 18 Apr 2004.

Diagnosis. *Alabes bathys* differs from all other species of *Alabes* by a combination of its moderately large gill opening (width 3.1–3.7 in HL), somewhat smaller pelvic fin rudiment (width 1.4–1.6 in gill opening) consisting of 2 apparent fin rays in each half, 4 cephalic pores (1 POP, 1 ANP, 2 LP) in the lateral line system, and its unique colour pattern.

Figure 1a. *Alabes bathys*, holotype, NMV A 14558, 39 mm SL, off Cape Sorell, Tas. (photograph courtesy of Rudie Kuiter, NMV).

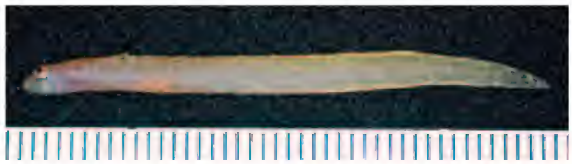

Figure 1b. *Alabes bathys*, paratype, CSIRO H.6156-01, 38 mm SL, west of King I., Tas. (photograph courtesy of Alastair Graham, CSIRO)

Table 1. Measurements (mm) and counts of the holotype and paratypes of *Alabes bathys* sp. nov.

	Holotype NMV A14558	Paratype NMV A28045-001	Paratype CSIRO H.6156-01
Standard length	39	29	38
Head length	5.2	3.9	4.4
Snout length	1.3	0.8	1.4
Eye diameter	1.6	1.2	1.5
Interorbital width	0.7	0.5	0.6
Gill slit width	1.4	1.1	1.4
Head width	2.4	2.1	2.4
Body width at gill slit	1.8	1.7	1.8
Body width (max.)	1.8	1.7	1.8
Body depth (max.)	3.0	2.3	2.9
Snout to dorsal-fin fold	14	9.2	15
Snout to anal-fin fold	19	11	22
Snout to anus	14	11	14
Ventral fin width	0.9	0.8	1.0
Caudal fin rays	8	7?	8
Postocular pores	1	1	1
Posterior nasal pores	0	0	0
Anterior nasal pores	1	1	1
Dorsal lacrymal pores	1	1	1
Ventral lacrymal pores	1	1?	1
Sex	?	?	?

Description. Measurements of the holotype and paratypes are presented in Table 1 (counts and proportions in parentheses in the following description represent those of the paratypes where different from the holotype). Body elongate, subcylindrical, widest anteriorly (maximum body width at level of gill slit 21.7 [17.1–21.1] in SL), reaching a maximum depth about middle of body (depth 13.0 [12.6–13.1] in SL), tapering posteriorly; head small, cylindrical, length 7.5 (7.4–8.6) in SL, slightly wider than body, width 2.1 (1.8–1.9) in HL; snout short, round to slightly truncate in dorsal view, length 4.0 (3.1–4.6) in HL; nostrils small but obvious, anterior 1 tubular, posterior 1 with low raised rim; eye moderate in size, with prominent clear cornea, diameter of orbit 3.3 (2.9–3.3) in HL, bony interorbital rather narrow, width 7.4 (7.3–7.8) in HL.

Skin smooth and scaleless, usually covered with mucus layer; lateral line sensory system consists of small open pores and minute papillae (latter very difficult to detect); 4 pores on each side of head, consisting of 1 POP and 1 ANP, and 2 LP. Gill opening a moderately wide slit, located on ventral surface of head, length 3.7 (3.1–3.5) in HL; gills 3?; branchiostegals 3; mouth terminal, gape not reaching vertical line through anterior margin of eye (pigmented area), lips narrow, somewhat fleshy; teeth in cleared and stained paratype small, conical, canine-like, 1 row of 6–8 teeth on each side of upper and lower jaws, largest anteriorly (premaxilla also with 3 much smaller teeth forming a 2nd row along inner base of main row); palatine and vomerine teeth absent. Dorsal and anal-fin folds resemble low fins, but lack both fin rays and underlying pterygiophores; caudal fin with 8 (7–8) fin rays, continuous with dorsal and anal-fin folds; bases of dorsal and anal-fin folds relatively long, insertion of dorsal-fin fold over or slightly behind vertical through urogenital opening, insertion of anal-fin fold well behind vertical through urogenital opening (snout to insertion of dorsal-fin fold 2.7 [2.6–3.2], snout to insertion of anal fin fold 2.0 [1.7–2.6], snout to urogenital opening 2.8 [2.7–2.8], all in SL); urogenital opening with prominent papilla. Total vertebrae not known for holotype but cleared and stained paratype has a total of 68 vertebrae, not including hypural plate (21 precaudal), with last epineural on 24th vertebra.

Colour in alcohol. Head and body overall pale brown, fins more translucent.

Colour in life. (Based on colour transparency of holotype, see fig. 1a): head and body pale brown, abdominal region more pinkish ventrally; body becoming more translucent posteriorly, vertical fins almost totally transparent; middle of side with longitudinal series of whitish spots from head almost to caudal fin, each spot about equal or subequal to eye diameter; dorsal surface with longitudinal series of similarly coloured short cross-bands, continued onto dorsal-fin fold as vertical bars; a few pale spots on anal-fin fold. Larger paratype differs in its ground colour, being a more pale greyish green (fig. 1b).

Distribution. Alabes bathys is known only from western Tas., in the region of Cape Sorrell and King I..

Remarks. This species has so far only been collected by dredge from deep coastal waters at depths between 160 and 348 m. It shares with *Alabes dorsalis* a large ventral gill slit and prominent ventral fin rudiment, but differs in the relatively narrow width of the latter fin (maximum width 1.4–1.6 versus 0.8–1.0 for *A. dorsalis*, all in length of gill slit). It also has a narrower body (maximum depth 12.6–13.1 verus 9.3–11.6 in SL), lacks the dark circular markings along the body and its small size (maximum length 42 mm TL versus 120 mm TL in *A. dorsalis*).

Etymology. This species is named *bathys* (from the Greek "bathys" meaning deep) with reference to its deep water habitat.

Alabes springeri sp. nov.

Figure 2 ; Table 2

Alabes parvulus (*non* McCulloch) Springer and Fraser, 1976: 21.

Material examined. Holotype. AMS I.18497-001, 31 mm SL, Norfolk I., Emily Bay, Point Hunter (29°04'S, 167°57'E), rotenone at 1 m, C. Anderson et al., 16 Sep 1975.

Diagnosis. Alabes springeri differs from all other species of *Alabes* by a combination of its small gill opening (8.8 in HL), lack of a pelvic-fin rudiment, narrow interorbital space (8.8 in HL), presence of only 2 cephalic pores in the lateral line system, and the posteriorly placed origin of the dorsal-fin fold.

Description. Measurements of the holotype, the only known specimen, are presented in Table 2. Body elongate and subcylindrical, reaching a maximum depth at level of about anterior 3rd of body, then tapering posteriorly, body depth 11.1 in SL, maximum body width (= width at level of gill slit) 15.5 in SL; caudal peduncle absent (caudal fin joined to dorsal and ventral-fin folds); head small, length 7.0 in SL, a little wider than deep (head width 1.9 in HL); snout short, rather rounded to slightly truncate anteriorly in dorsal view, length 3.1 in HL; nostrils small but obvious, anterior one tubular, posterior one with low raised rim; eye moderate in size, with prominent clear cornea, diameter of orbit 3.7 in HL, noticeably greater than bony interorbital width (8.8 in HL).

Skin smooth and scaleless, normally covered with a thick mucus layer; lateral line sensory system consists of minute papillae (latter very difficult to detect); cephalic pores 2 on each side of head, 1 POP and 1 ANP. Gill opening a narrow slit, located on ventral surface of head, width 8.8 in HL; gills and branchiostegals not examined; mouth subterminal, upper jaw projecting over lower jaw, upper and lower lips rather narrow, rear corner of mouth not reaching anterior margin of eye (pigmented area); teeth incisorform, 1 row in upper and lower jaws; palatine and vomerine teeth absent. Dorsal and anal-fin folds resemble low fins, but lacking both fin rays and underlying pterygiophores, continuous with caudal fin; caudal fin without visible fin rays, although there is evidence that the posterior portion of the specimen was damaged at some time (portion of caudal and anal-fin folds lost, and some vertebral elements also protruding through side of body); bases of dorsal and anal-fin folds relatively short, insertion of dorsal-fin fold well behind vertical through urogenital opening (snout to insertion 1.8, snout to urogenital opening 2.6, both in SL), snout to insertion of anal-fin fold 1.4 in SL; urogenital opening with small papilla. Total vertebrae 71 (from Springer and Fraser, 1976), with last epipleural on 20th vertebra.

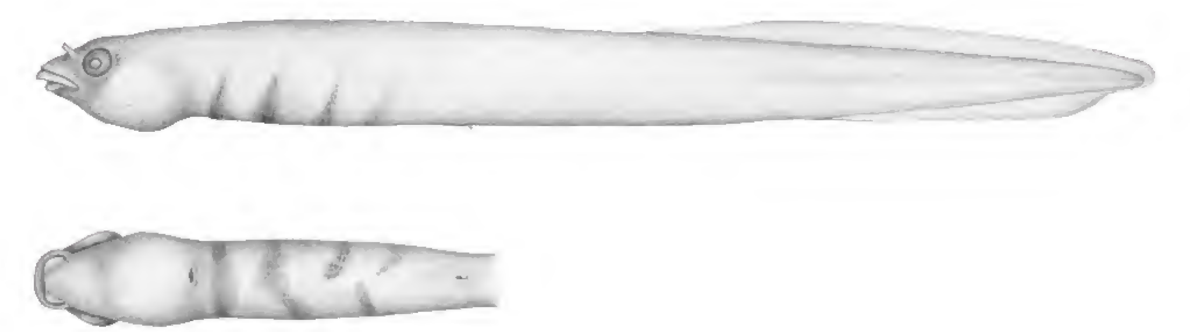

Figure 2. *Alabes springeri*, hototype, AMS I.18497-001, 31 mm SL, Norfolk I., Emily Bay, Point Hunter (illustration courtesy of Victor Springer, USNM).

Table 2. Measurements (mm) and counts of the holotype of *Alabes springeri* sp. nov.

	Holotype AMS I.18497-001
Standard length	31
Head length	4.4
Snout length	1.4
Eye diameter	1.2
Interorbital width	0.5
Gill slit width	0.5
Head width	2.3
Body width at gill slit	2.0
Body width (max.)	2.0
Body depth (max.)	2.8
Snout to dorsal fin fold	17
Snout to anal fin fold	22
Snout to anus	12
Caudal fin rays	0
Postocular pores	1
Posterior nasal pores	0
Anterior nasal pores	1
Dorsal lacrymal pores	0
Ventral lacrymal pores	0
Sex	Male?

Colour in alcohol. Head and body overall pale brown, fins more translucent. Springer and Fraser, 1976 illustrated some partial cross banding on the abdominal region, triangular in shape (see fig. 2), but this has since faded.

Colour in life. Unknown

Distribution. *Alabes springeri* is known only from the type locality (Norfolk I.).

Remarks. This species inhabits shallow coastal waters (single specimen taken from a depth of 1 m). It is most similar to *Alabes parvula* from eastern Australia, differing in the exceptionally short base of the dorsal-fin fold, different shape of the dark bars on the side of the abdomen (triangular-shaped versus more squarish in *A. parvula*), and the expanded shape of the buccal region (not expanded in *A. parvula*). Like other members of the *Alabes parvula* complex (*A. parvula*, *A. occidentalis*, and *A. hoesei*), it lacks a pelvic fin rudiment, has a very small gill slit, its body probably is transparent in life (at least posterior to urogenital opening), and its maximum size is less than 50 mm TL (see Table 1 in Hutchins and Morrison, 2004). This species is named *springeri* in honour of V.G. Springer (USNM) who, with T. Fraser in 1976, first reported the apparent uniqueness of the Norfolk Island specimen. (NB. registration number AMS I.18470-002 was inadvertently assigned to this specimen by Springer and Fraser, 1973: 21, but that number belongs to one of the paratypes of *Alabes hoesei* which was described in the same paper).

Acknowledgements

I am grateful to Alastair Graham (CSIRO), Martin Gomon (NMV) and Mark McGrouther (AMS) who provided the material on loan that was used in this study. Victor Springer (USNM) kindly gave advice on the description of the new *Alabes* from Norfolk Island, and offered me the use of a previously published illustration of this species (from Springer and Fraser, 1976).

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Revision of the genus *Hapalogenys* (Teleostei: Perciformes) with two new species from the Indo-West Pacific

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Abstract Iwatsuki, Y., and Russell, B.C. 2006. Revision of the genus *Hapalogenys* (Teleostei: Perciformes) with two new species from the Indo-West Pacific. *Memoirs of Museum Victoria* 63(1): 29–46.

The Indo-West Pacific genus *Hapalogenys* is reviewed and two new species are described: *Hapalogenys dampieriensis* sp. nov. from Australia and *H. filamentosus* sp. nov. from the Philippines. The genus now includes: *Hapalogenys analis* Richardson, *H. dampieriensis* sp. nov., *H. filamentosus* sp. nov., *H. kishinouyei* Smith and Pope, *H. merguiensis* Iwatsuki, Ukkrit and Amaoka, *H. nigripinnis* (Schlegel in Temminck and Schlegel) and *H. sennin* Iwatsuki and Nakabo. *Hapalogenys dampieriensis*, *H. filamentosus* and *H. kishinouyei* are similar to each other in overall body appearance and are accordingly identified as the "*Hapalogenys kishinouyei* complex", defined by having 2–5 longitudinal stripes on the body. *Hapalogenys dampieriensis* has long been confused with *H. kishinouyei* in having similar longitudinal dark stripes, but the two species are easily separable on meristic and morphometric values, and body colour changes with growth. *Hapalogenys filamentosus* differs from *H. dampieriensis* in having a longer pelvic fin, with the filamentous first fin ray almost reaching to or slightly beyond the base of first anal-fin spine when depressed (vs. slightly beyond anus but not reaching to base of first anal-fin spine) and two faint narrow longitudinal stripes on the body (vs. four narrow longitudinal stripes in juveniles, reducing to two with growth). A neotype is designated for *H. analis*. Species of *Hapalogenys* can be distinguished from one another on the basis of meristic and morphometric characters, body colour pattern, maximum size and distribution. The familial position of *Hapalogenys* is briefly discussed.

Keywords Taxonomy, Pisces, Perciformes, Revision, *Hapalogenys dampieriensis* sp. nov., *Hapalogenys filamentosus* sp. nov.

Introduction

In a study of the Indo-West Pacific genus *Hapalogenys*, Iwatsuki et al., 2000a pointed out the taxonomic confusion among *Hapalogenys* species from Japan. Subsequently, Iwatsuki and Nakabo, 2005 redescribed *H. nigripinnis* and proposed a new species, *H. sennin*. Ongoing investigations of all nominal species of *Hapalogenys,* including those now included in the family Dinopercidae and the genus *Parapristipoma* (Heemstra and Hecht, 1986; Iwatsuki et al., 2000a, b; Heemstra and Iwatsuki, in press; see Discussion), have resulted in the recognition of five species of *Hapalogenys* from the Indo-West Pacific, plus two new species described herein.

Hapalogenys kishinouyei Smith and Pope, 1906, described from Japan, was long considered an endemic East Asian shelf species. However, Gloerfelt-Tarp and Kailola, 1984 reported it from north-western Australia, their specimens having similar longitudinal stripes on the body, and believed it to be an antitropical species. The East Asian *H. kishinouyei* though are separable from Australian specimens on the basis of counts, proportional measurements, different changes in colouration with growth, and maximum body size. In this paper we conclude that the Australian specimens represent an undescribed species of *Hapalogenys*. A second new species from the Philippines, similar to the Australian species in overall appearance, but differing in having a long pelvic fin with a filamentous first ray and two faint, longitudinal stripes on the body (vs. four at the same size), is also described.

The following account reviews the genus *Hapalogenys* from the Indo-West Pacific, including two new species, on the basis of all known types and a wide range of non-type specimens, from a wide geographic area. The familial position of *Hapalogenys* is briefly discussed.

Methods

Counts and measurements follow Iwatsuki et al., 2000a. Terminology generally follows Johnson, 1980, 1984, although that of the supraneural bones follows Mabee, 1988 and the formula of Ahlstrom et al., 1976. Institutional codes follow Leviton et al., 1985, with the following additions: Division of Fisheries Sciences, University of Miyazaki, Japan (MUFS); Phuket Marine Biological Center, Thailand (PMBC); Kanagawa Prefectual Museum, Kanagawa, Japan (KPM). The very short dense papillae and barbels on the fleshy lower lip in *Hapalogenys analis* (MUFS 7148, 12258) and *H. sennin* (MUFS 2086, 12225) necessitated dissection so as to determine the number of pores on and posterior to the chin.

Systematics

Hapalogenys Richardson, 1844

Hapalogenys Richardson, 1844a: 462 (type species not designated).–Bleeker, 1876: 271 (*Hapalogenys nitens* subsequently designated as type species by Richardson, 1844b [=*H. nigripinnis* Schlegel in Temminck and Schlegel, 1843], see Iwatsuki and Nakabo, 2005).–Johnson, 1984: 465 (placed as *incertae sedis* in Percoidei).–Springer and Raasch, 1995: 93, 104 (established family name Hapalogenidae [sic. Haplogeniidae] for this genus).–Iwatsuki et al., 2000a: 129.–Iwatsuki and Nakabo, 2005: 854.

Definition of the genus *Hapalogenys*

Body compressed, elevated; mouth moderate, horizontal; upper jaw protractile; 10 pores on and behind chin, including a pair of very small pores near symphysis (often hidden by cluster of short dense barbels or papillae, especially in *Hapalogenys analis* and *H. sennin*), plus 2 pores anteroventrally on dentary (often hidden by cluster of short dense barbels or papillae, especially in *H. analis* and *H. nigripinnis*), a single pore ventrally, midway along each dentary and a single pore ventrally at articulation between dentary and angular (sometimes slit-like in *H. dampieriensis* sp. nov., *H. sennin* and *H. kishinouyei*, a pit partially or entirely covered posteriorly by membrane in *H. nigripinnis* and *H. sennin*, especially in larger adults); a cluster of short or long, crowded papillae and barbels on and behind chin, generally developed with age; snout tip naked or with small papillae; teeth uniformly small, in bands on jaws, vomer, and palatines; preopercle serrate; opercle with 1 or 2 short spines; 7 branchiostegals; pseudobranchiae present; air bladder simple; pyloric appendages few; pored lateral-line scales 41–48; soft vertical fins scaled basally; dorsal surface of head, including snout, jaws and opercular elements scaly; dorsal-fin spines 11 with antrorse spine anteriorly (the antrorse spine is, in fact, an anterior projection of the 1st pterygiophore, not a fin spine), rays 13–15; anal fin with 3 spines (2 supernumerary spines on 1st anal pterygiophore; see Johnson, 1980), usually 9 rays (rarely 8); caudal fin generally rounded; pectoral fin pointed; dorsal- and anal-fin pterygiophores with separate proximal, middle and distal radials; supraneural formula 0/0+0/2/1+1/; principal caudal-fin rays 9+8; procurrent rays 5 or 6+5 or 6 (upper + lower); caudal skeleton with 5 hypurals, 3 epurals, 2 uroneurals and 2 autogenous haemal spines; hypural fusions absent; procurrent spur absent; vertebrae 10+14.

Relationships

The genus *Hapalogenys* has been traditionally placed in the Haemulidae (Akazaki, 1984; McKay, 2001, Nelson 2006), although Johnson, 1984 included it as "*incertae sedis*" in the Percoidei because of its uncertain affinities. Springer and Raasch, 1995 established a new family name, Hapalogenidae (sic. Haplogeniidae), for the genus, but without any strong supporting evidence. McKay, 2001 also recognised *Hapalogenys* as removed from the Haemulidae, although he retained it in that family for convenience. He reported *Hapalogenys* is very close to the two species of the family Dinopercidae, but lacks intrinsic muscles on the posterior part of the swimbladder. Based on similarities of larval morphology with *Lobotes* and *Datnioides* (= *Coius*), Leis and Carson-Ewart, 2000, 2004 placed *Hapalogenys* in a group they informally called '*Lobotes*-like', and suggested a possible relationship of *Hapalogenys* to lobotids. Clearly, further study is needed to clarify the familial position of *Hapalogenys*, and until its relationships to other genera can be resolved we provisionally retain *Hapalogenys* in the Haemulidae.

Key to species

1. Scales on maxilla (figs 3A and C) 2
— No scales on maxilla (figs 3C, 3E, 3G and 4A, E) 3
2. Head and body with 2 oblique dark bands (rarely indistinct), 1st descending from nape to behind pectoral fin and running to posterior part of soft anal-fin rays, 2nd descending from base of anterior 3rd or 4th dorsal-fin spines and soft dorsal-fin base, curving backwards through lateral line to upper part of caudal peduncle (fig. 1G); posterior margin of soft dorsal, anal and caudal fins not dense black (fig. 1G); spinous dorsal-fin membranes mostly yellowish brown, not dense black (fig. 1G) .... *Hapalogenys nigripinnis* (fig. 1G)
— Head and body with 5–7 alternating whitish and dark-brown bands, 1st (often indistinct) from just before eye to posterior of lower jaw, 2nd somewhat oblique, extending from nape across opercle to pelvic-fin base (becoming wider posteroventrally), 3rd from base of 2nd and 3rd dorsal-fin spines to just behind pelvic-fin base; posterior margin of soft dorsal, anal and caudal fins dense black (fig. 1A); spinous dorsal-fin membrane dense black (fig. 1A) .... *Hapalogenys analis* (fig. 1A)
3. Body with 2 oblique dark bands or sometimes no bands 4
— Body with 2–5 longitudinal dark stripes (sometimes indistinct or faint but visible), 1st from front of 1st dorsal-fin spine along dorsal midline, 2nd from nape to base of mid dorsal-fin soft rays, 3rd from eye to last dorsal-fin ray base, 4th from preopercular flange, through base of pectoral fin, to lower caudal peduncle, last from isthmus to base of anal spinous fin (fig. 2E) 5
4. 1st dark band on body descending from nape to behind pectoral fin, and 2nd from base of anterior 2nd or 3rd dorsal-fin spines and soft dorsal-fin base, curving backwards through lateral line to soft anal-fin and caudal peduncle (fig. 1F), but bands often lost in preserved specimens; orbit diameter large (3.5–3.8 in head length); papillae on fleshy lower lip well-developed but very short on chin (figs 4A–B) .... *Hapalogenys merguiensis* (fig. 1F)

— 1st dark band descending from nape to behind pectoral fin, and 2nd descending from base of 7–10th dorsal-fin spines, curving downwards above or through lateral line, but bands often lost in preserved specimens (fig. 1H): orbit diameter small (7.4–12.7 in head length); barbels on fleshy lower lip extremely well-developed and in a dense cluster on chin (figs 4E–F) .... *Hapalogenys sennin* (fig. 1H)

5. Filamentous tip of 1st pelvic-fin ray almost reaching to or slightly beyond base of 1st anal-fin spine when depressed (figs 1C–D); 2nd and 3rd longitudinal dark stripes on body faint (fig. 1C); posteriormost angle of jaw reaching to a vertical through centre of eye in specimens between 130–160 mm SL (figs 1C–D) .... *Hapalogenys filamentosus* sp. nov. (fig. 1C)

— Filamentous tip of 1st pelvic-fin ray extending slightly beyond anus but clearly not reaching to base of 1st anal-fin spine when depressed (figs 1A–B, 1E–H); 4th and 5th longitudinal dark stripes on body indistinct or absent (figs 1A, 1E, 2A–F); jaw reaching to slightly behind a vertical through anteriormost eye membrane in specimens between 130–160 mm SL (figs 1C, 2B–C, 2E–F) 6

6. 3rd body stripe narrow, its width below base of 5th and 6th dorsal-fin spines less than pupil diameter in specimens smaller than about 170 mm SL, 3rd, 4th and 5th stripes lost in specimens larger than 200 mm SL (figs 1B, 2A–C) .... *Hapalogenys dampieriensis* sp. nov. (figs 1B, 2A–C)

— 3rd stripe broad, its width below base of 5th and 6th dorsal-fin spines greater than pupil diameter at all sizes; 1st, 4th and 5th stripes lost in specimens larger than about 250 mm SL (figs 1E, 2D–F) .... *Hapalogenys kishinouyei* (figs 1E, 2D–F)

Hapalogenys analis Richardson, 1845

English Name: Broadbanded Velvetchin
Japanese Name: Setodai

Figures 1A, 3A–B

Hapalogenys analis Richardson, 1845**:** 85, pl. 43, fig. 1 (type locality: Canton, China).–Whitehead, 1970: 215 (Canton, China).–Bauchot et al., 1983: 32 (Canton, China).

Pristipoma mucronata Eydoux and Souleyet, 1850 (as 1841 but erroneous, see Bauchot et al., 1982): 161, pl. 2, fig. 1 (type locality: Macao, China).

Hapalogenys mucronatus Günther, 1859: 318 (China).–Bleeker, 1865–1869: 56, 58 (Amoy, China).–Ishikawa and Matsuura, 1897: 54 (Tokyo).–Jordan and Thompson, 1912: 553 (Kobe, Hyogo and Onomichi, Hiroshima).–Izuka and Matsuura, 1920: 150 (Osaka).–Tanaka, 1925: 888, pl. 181, fig. 495 (Tadanoumi).–Fowler, 1930: 605 (Japan).–Shen, 1993: 360, pl. 101 (Kaoshung, Taiwan).–Cheng et al., 1997: 257 (Shandong Province, China).–Sadovy and Cornish, 2000: 229 (Hong Kong, China).–Wang et al., 2001: 223 (Heibei, China).

Hapalogenis mucronatus Steindachner and Döderlein, 1883: 11 (Osaka).

Type material. Neotype: MUFS 12258 (fig. 1A), 185 mm SL, East China Sea, bottom trawl, 50–100 m depth, 12 June 1996.

Non-type material. 72–201 mm SL, *n*=49. FAKU 12098, 88 mm SL, East China Sea; FAKU 12098, 72 mm SL, East China Sea; FAKU 29281, 137 mm SL, off Yamaguchi, Sea of Japan; FAKU 34879,153 mm SL, off Ehime, Bungo Channel; FAKU 100314–100316, 3: 108–137 mm SL, Gulf of Tong-king, northern Vietnam; FRLM 8115, 8145, 2: 87–114 mm SL, East China Sea (31°9'N, 125°00'E, 31°20'N, 125°10' E), trawl, less than 100 m depth; FRLM 8170–8172 and 8189, 4: 102–133 mm SL, East China Sea (31°23'N, 125°05'E, 31°10'N, 125°10'E), trawl, less than 100 m depth; HUMZ 49427–49430, 4: 87–131 mm SL, Yahatahama Market, Ehime, Japan; HUMZ 71708, 115 mm SL, Kaoshung Fish Market, Taiwan; HUMZ 106037, 166 mm SL, Saeki Fish Market, Oita, Japan; HUMZ 108351, 108415, 108650, 74–95 mm SL, East China Sea, about 81–86 m depth; IOCAS 51-118, 117 mm SL, off Chingtao, China; IOCAS 57-1549, 2001, Ryonin, China; IOCAS 73-211, off Amoy China; MNHN 7702 (holotype of *Pristipoma mucronata*), 154 mm SL, near Macao; MUFS 2308, 87 mm SL, Kiryu, Taiwan; MUFS 7148, 129 mm SL, Akamizu, Nobeoka, Miyazaki, Japan, set net, less than 30 m depth; MUFS 8652, 143 mm SL, bottom trawl, 50–100 m depth, off Nobeoka, Miyazaki, Japan; NSMT-P 2116, Kasaoka, Seto Inland Sea; SFU 58-2573, 165 mm SL, off Shanghai, China; SFU 3862-3863, 2: 81–181 mm SL, Shanghai, China; URM-P 751, 102 mm SL, East China Sea; URM-P 10446–10448, 3: 91–95 mm SL, Akashi, Hyogo, Seto Inland Sea; URM-P 19090, 19692–19694, 19737, 5: 90–147 mm SL, East China Sea; URM-P 23097, 112 mm SL, Tainan, Taiwan; ZRC 38018, 105 mm SL, W coast of Singapore; ZRC 41178, 105 mm SL, Razaras I., Singapore.

Diagnosis. A species of *Hapalogenys* with the following combination of characters: fleshy lower lip with dense cluster of short papillae and barbels anteriorly, 10 pores on and behind chin, 4 anterioriormost pairs hidden by papillae (figs 3A–B), slightly scaly posteriorly (on posterior abdominal part of angular of lower jaws, fig. 3B); small scales on maxilla (fig. 3A); 5–7 alternating whitish and dark-brown bands on head and body, 1st (often indistinct) from just before eye to posterior of lower jaw, 2nd somewhat oblique, becoming wider posteriorly, from nape to between eye and pelvic-fin base, 3rd from base of 2nd and 3rd dorsal-fin spines to just behind pelvic-fin base; 4th from 7th and 8th dorsal-fin spine base to just before 1st anal-fin spine, 5th from 2nd and 3rd dorsal-fin soft ray base to anterior of anal-fin soft ray base, 6th on caudal peduncle, 7th (often indistinct) on caudal-fin base; soft rayed portions of dorsal and anal fins somewhat rounded posteriorly and slightly angulated posteriorly, respectively (fig. 1A), spinous dorsal-fin and anal-fin (until 1st anal-fin ray) membranes dense black; membrane of soft dorsal- anal- (especially in juveniles and young) and caudal-fins somewhat yellowish in fresh specimens, a dense black margin posteriorly, about same width as pupil diameter (juveniles) or half of this width (adults) (fig. 1A); pelvic-fin tip not reaching to base of 1st anal-fin spine when depressed (fig. 1A); 44–47 (but rarely 43 or 48) pored lateral-line scales; procumbent spine-like process (exposed tip of 1st pterygiophore) at origin of dorsal fin usually covered by predorsal scales.

Description. Counts and proportional measurements as percentage of SL for the neotype and other specimens are given in Table 1. Data for the neotype are presented first, followed by non-type material (if different) in parentheses. Characters given in the diagnosis are not repeated.

Body deep, 49% of SL (47–57% of SL), relatively compressed, covered with ctenoid scales, ctenii free on posterior margin of exposed area; lateral line continuous until on hypural plate; orbit diameter distinctly larger than interorbital space; suborbital depth distinctly less than eye diameter; head covered

Table 1. Counts and proportional measurements, and characters as percentage of standard length for the neotype and non-type specimens of *Hapalogenys analis* Richardson, 1845

	Hapalogenys analis		
	Neotype MUFS 12258, 185 mm SL	Non-type specimens 72–201 (mean 116) mm SL n=49	
Dorsal-fin rays	XI, 15	XI, 15–16	
Anal-fin rays	III, 9	III, 9 (rarely 10)	
Pectoral-fin rays	19 (i + 18)	18–19 (rarely 20)	
Pelvic-fin rays	I, 5	I, 5	
Pored lateral-line scales	45 + 4	44–47 but rarely 43 or 48	
Scale rows above and below lateral line	11 / 24	10–14 (rarely 9) / 22–24 (rarely 21)	
Gill rakers including all rudiments	6 + 14	6–7 + 13–14	
Body depth	49	47–57	(52)
Body depth at anal-fin origin	43	42–65	(46)
Head length	38	36–57	(39)
Body width	19	17–30	(20)
Snout length	13	12–20	(14)
Dermal eye opening	9	8–14	(10)
Orbit diameter	10	10–16	(12)
Suborbital depth	7	6–10	(6)
Interorbital width	9	7–12	(8)
Upper jaw length	15	14–22	(15)
Caudal-peduncle depth	11	11–18	(13)
Caudal-peduncle length	15	13–23	(16)
Predorsal length	45	42–68	(48)
Preanal length	70	65–100	(69)
Prepelvic length	43	39–44	(62)
Dorsal-fin base	61	56–88	(62)
Anal-fin base	18	17–28	(20)
Caudal-fin length	24	21–35	(27)
Pelvic-fin spine	18	16–27	(19)
First pelvic-fin ray	6	25–39	(30)
Longest pectoral-fin ray	28	23–37	(27)
First dorsal-fin spine	6	6–10	(7)
Second dorsal-fin spine	13	10–19	(14)
Third dorsal-fin spine	31	27–42	(31)
Fourth dorsal-fin spine	25	21–35	(25)
Fifth dorsal-fin spine	24	19–32	(23)
Last dorsal-fin spine	11	8–14	(11)
First dorsal-fin ray	—	17–27	(20)
Second dorsal-fin ray (longest)	22	18–31	(22)
First anal-fin spine	9	22–24	(23)
Second anal-fin spine	20	8–12	(10)
Third anal-fin spine	12	19–28	(23)
First anal-fin ray	17	11–20	(14)
Second anal-fin ray	22	18–31	(21)
Longest anal-fin ray (third or fourth)	22	18–33	(22)

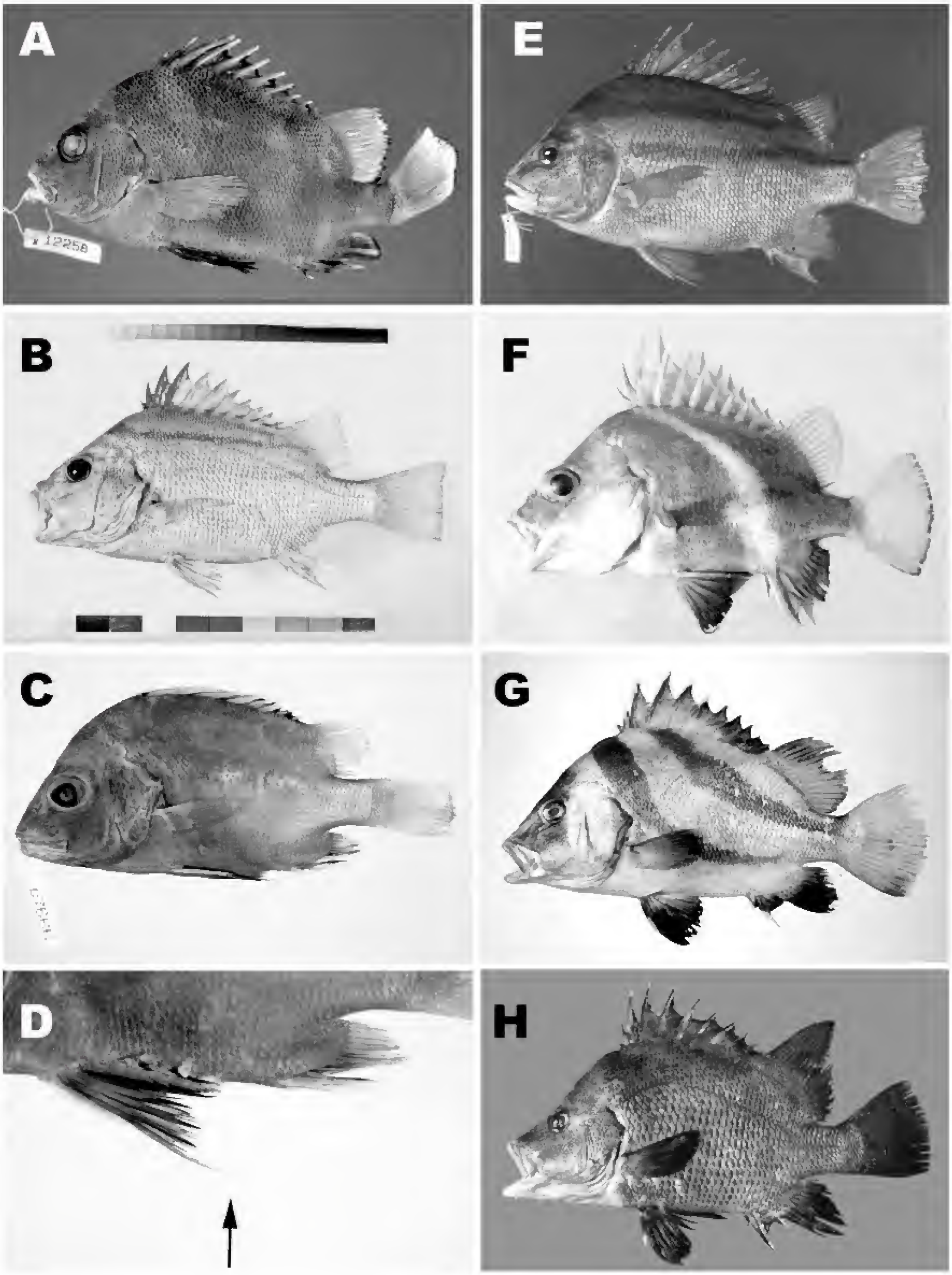

Figure 1. The seven species of *Hapalogenys*. A), *H. analis*, MUFS 12258, 185 mm SL, East China Sea; B) *H. dampieriensis* sp. nov., CSIRO C4036-02, Holotype, 224 mm SL, N of Cape Lambert, north-western Australia; C), *H. filamentosus* sp. nov., MUFS 7666, holotype, off Iloilo, Panay Is., Philippines; D), Right pelvic-fin (reversed) of *H. filamentosus* sp. nov., MUFS 7666, holotype; E), *H. kishinouyei*, MUFS 12316, 266 mm SL, Miyazaki, Kyushu, Japan; F), *H. merguiensis*, PMBC 10985, paratype, 199 mm SL, off Satun Province near Phuket, Andaman Sea; G), *H. nigripinnis*, Kanagawa Prefectual Museum's photo database (KPM-NR0001009, photographed by T. Suzuki), about 180 mm SL, Moroyose, Hyogo, Sea of Japan; H), *H. sennin*, MUFS11649, holotype, 232 mm SL, Meitsu, Miyazaki, Japan. Arrow shows tip of pelvic-fin ray.

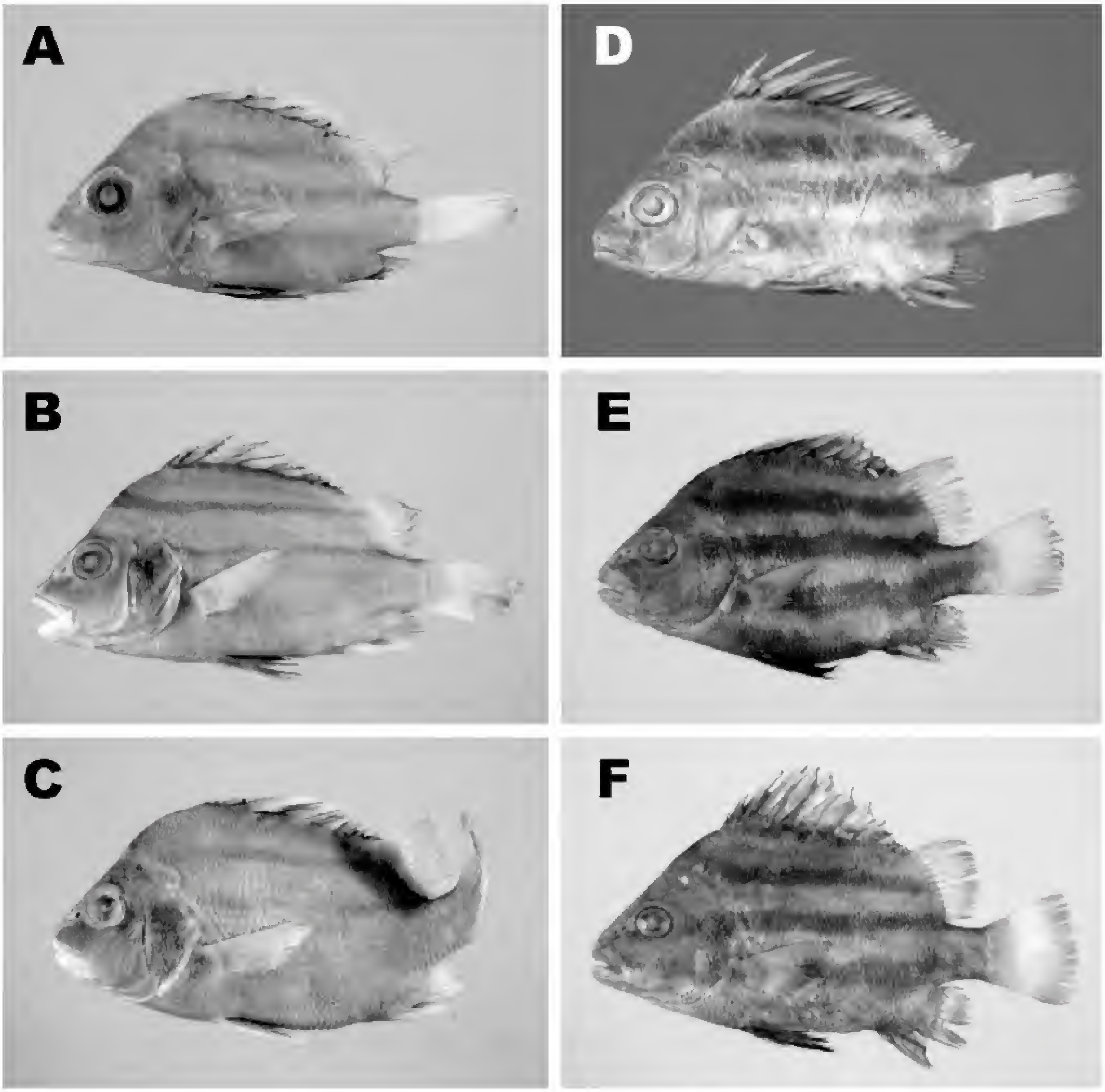

Figure 2. Three stages of 2 species, *Hapalogenys dampieriensis* sp. nov. (A–C) and *H. kishinouyei* (D–F). A), AMS I.22805-035, paratype, 65 mm SL, Northwest Shelf, 170 km off Port Headland, Australia, B), NTM S.13569-010, paratype, 134 mm SL, Arafura Sea, Australia, C), AMS I 22805-035, paratype, 158 mm SL, Northwest Shelf, 170 km off Port Headland, Australia, D) USNM 55610, holotype, 81 mm SL, Tokyo, Japan, E), MUFS 20896, 131 mm SL, Meitsu, Nango, Miyazaki, Japan, F), MUFS 14286, 168 mm SL, Meitsu, Miyazaki. Japan.

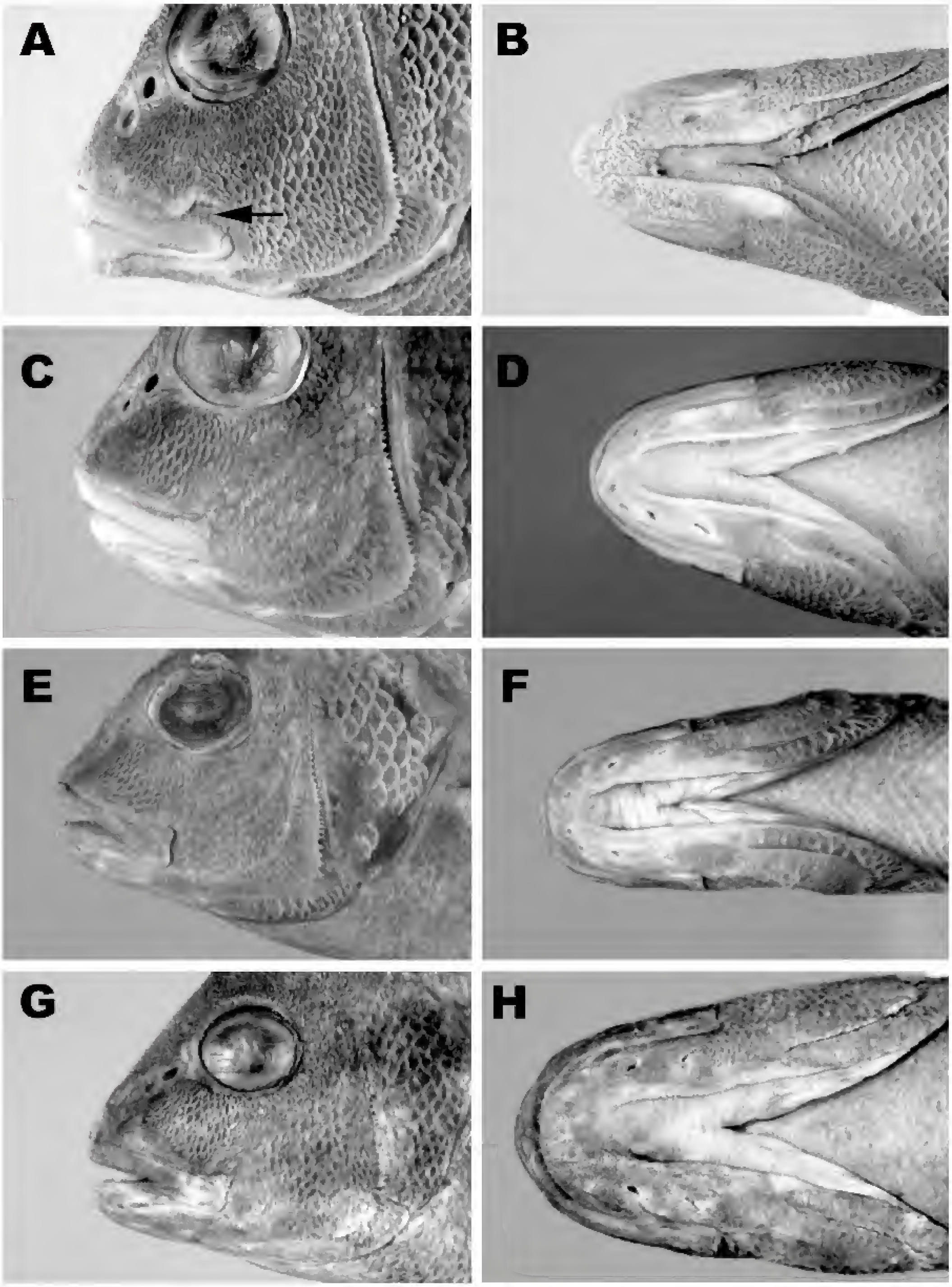

Figure 3. Head (left) and lower jaw ventral view (right) of 4 species, *Hapalogenys analis* (A–B), *H. dampieriensis* sp. nov. (C–D), *H. filamentosus* sp. nov. (E–F) and *H. kishinouyei* (G–H). A–B), HUMZ 106037, 113 mm SL, Saeki, Ooita, Japan; C–D), NTM S13510-010, 134 mm SL, Arafura Sea, Northern Territory, Australia; E–F), MUFS 7654, 134 mm SL, off Iloilo, Panay Is., Philippines; G–H), MUFS 20986, 131 mm SL, Meitsu, Miyazaki, Japan. Arrow indicates squamation on maxilla.

with scales, extending almost to anterior nostrils; lips, chin and ventral part of urohyal naked; cheek and opercle fully scaled; jaws with bands of pointed conical teeth, outermost teeth generally enlarged, but not forming canines; teeth absent on vomer and palatines; preopercle serrate; upper opercle with 2 short spines posteriorly; single notched dorsal fin; 3rd dorsal-fin spine and 2nd dorsal-fin ray longest; 1st dorsal- and anal-fin soft rays not strongly bifurcated; 1st anal-fin spine short, 2nd longest, clearly longer than 3rd; dorsal and anal fins with high scaly sheath; caudal fin generally rounded.

Live colouration. Based on photograph of MUFS 12258 (fig. 1A), neotype, 185 mm SL and MUFS 8422, 113 mm SL: head and body generally dark brownish, with 7 alternating whitish and dark brown bands (see Diagnosis); iris black; lips, lower part of cheek, preopercle and interopercle pale brownish.

Preserved colouration. Based on the neotype and non-type specimens: head and body generally similar to live colouration.

Distribution. Hapalogenys analis is currently known from the East Asian Shelf to the Sea of Japan and Pacific coast of southern Japan (except Ryukyu and Ogasawara Is.), including the western part of Taiwan and South China Sea (fig. 5). Lim, 1994 questionably reported *H. analis* from Singapore (3 collected specimens in total) (K. K. P. Lim, ZRC, pers. comm.).

Ecological note. Most specimens of *Hapalogenys analis* have been collected by bottom trawl in depths less than 100 m. Smaller specimens (< about 100 mm SL) have been collected by set nets in depths of 20–50 m.

Remarks. The date of publication of *Hapalogenys mucronatus* Eydoux and Souleyet (as 1841 on cover, but presumably 1850) and status of that species as a junior synonym of *H. analis* Richardson, 1845 as given by Bauchot et al., 1982, 1983, Lim, 1994, and Iwatsuki et al., 2000a is followed here. The type specimens of *H. analis* Richardson, 1845 are lost (J. Maclaine, BMNH, pers. comm.) and a neotype (MUFS 12258, 185 mm SL) of the species is herein designated in order to avoid confusion.

Hapalogenys dampieriensis sp. nov.

New English name: Australian Striped Velvetchin

Figures 1B, 2C–D

Hapalogenys kishinouyei.—non Smith and Pope, 1906: Gloerfelt-Tarp and Kailola, 1984: 197, upper 2nd left picture of p. 196 (north-western Australia).–Sainsbury et al., 1985: 214, lowest picture on p. 215 (north-western Australia).–Allen and Swainson, 1988: 82 (north-western Australia).–Allen, 1997: 128 (north-western Australia and south-eastern Asia).–McKay, 2001: 2969 (in part, north-western Australia).–Hutchins, 2001: 34 (Western Australia).

Type material. Holotype: CSIRO C4036-02, 224 mm SL, north of Cape Lambert, WA, Australia (19°09'S, 117°26–117°28'E), 121–123 m depth, 1 Sep 1995, coll. A. Graham and G. Yearsley. Paratypes: (all from Australia, *n* =8): AMS I.22805-035, 3: 66–158 mm SL, North-west Shelf, 170 km N of Port Hedland, WA (18°28'S, 118°15'E), 150–156 m depth, 28 Mar 1982, coll. J. Paxton and M. McGrouther; NTM S.13569-010, 3: 127–134 mm SL, 104–108 m depth, Arafura Sea, NT, 18 Oct 1992, coll. R. Williams; CSIRO CA244, 290 mm SL, north-west of Montebello I., WA (19°58'–19°57'S, 115°12'–115°14'E), 10 May 1978, coll. CSIRO; CSIRO CA1552 (voucher specimen based on Sainsbury et al., 1985), 231 mm SL, north-east of Monte Bello I., WA (19°34'–19°36'S, 116°09'–116°12'E), 7 Jun 1980, coll. CSIRO.

Non-type material. 66–300 mm SL, all from Australia, n=17. CSIRO H4036-03, 194 mm SL, northern Cape Lambert, WA (19°09'S, 117°26'–117°28'E), 1 Sep 2002, coll. A. Graham and G. Yearsley; CSIRO H4069-03, 81 mm SL, north-west of Port Hedland, WA (18°38'–18°39'S, 118°7'–118°8' E), 8 Sep 1995, coll. A. Graham and G. Yearsley; CSIRO H4069-04, 2: 74–75 mm SL, north-west of Port Headland, WA (18°38'–18°39'S, 118°7'–118°8'E), 8 Sep 1995, coll. A. Graham and G. Yearsley; CSIRO CA1106–CA1107, 2: both 192 mm SL, off western Admiralty Bay, WA, 9 Nov, 2002; NTM S12819-002, 300 mm SL, Evans Shoal, Timor Sea, NT, 22 Apr 1990, coll. J.Lloyd; NTM S13373-010, 172 mm SL, 87 m depth, Arafura Sea, NT, 30 Oct 1990, coll. NT Fisheries; NTM S.13569-010, 2: 127–129 mm SL, Arafura Sea, NT, 18 Oct 1992, coll. R. Williams; NTM S13523-008, 169 mm SL, 97–103 m depth, Arafura Sea, NT, 18 Sep 1992, coll. R. Williams, NTM S.13547-002, 65 mm SL, Arafura Sea, NT, 31 Oct, 1992, coll. R. Williams; WAM P25836-002, 269 mm SL, Bernier I., WA (24°40'S, 112°27'E), 128–161 m depth; WAM P26194-018, 166 mm SL, N of Monte Bello I., off Dampier, WA (19°26'S, 116°31'E), 120–128 m depth; WAM P26195-016, 97 mm SL, north of Monte Bello I., off Dampier, WA (19°10'S, 116°46'E), 175–178 m depth; WAM P27244-002, 215 mm SL, Rowley Shoals, WA (18°37'S, 119°33'E), 114 m depth; WAM P30426-001, 248 mm SL, West of Barrow I., off Onslow, WA (20°40'S, 113°43'E), 225–230 m depth; WAM P30658-002, 221 mm SL, 6 miles, NE of Monte Bello I., WA (20°26'S, 115°32'E); WAM P30666-001, 224 mm SL, Broome, WA (17°58'S, 122°14'E).

Diagnosis. A species of *Hapalogenys* with the following combination of characters: fleshy lower lip with dense cluster of very short papillae anteriorly (figs 3C–D), scaly posteriorly (on posterior abdominal part of angular of lower jaws, [fig. 3D]; 10 unobstructed pores on and behind chin (posteriormost 2 sometimes slit-like) (see figs 3C–D; Gloerfelt-Tarp and Kailola, 1984: 197, fig. 2); no scales on maxilla (figs 3C–D); 4 narrow longitudinal dark stripes (2nd and 3rd stripes most distinct, 2nd from nape to base of mid dorsal-fin soft rays, 3rd from eye to last dorsal-fin ray base) in specimens less than about 100 mm SL, thereafter 2nd and 3rd stripes visible only, remainder and 3rd stripes not present in specimens less than about 200 mm SL (figs 1B, 2A–C), their width below base of 5th and 6th dorsal-fin spines clearly narrower than pupil diameter (see figs 2A–C in 65–158 mm SL and fig. 1B); 41–45 pored lateral-line scales; soft rayed portions of dorsal and anal fins somewhat truncated posteriorly and slightly angulated posteriorly, respectively (figs 1B, 2A–C); pelvic-fin tip extending slightly beyond anus but clearly not reaching to base of 1st anal-fin spine when depressed (figs 1B, 2A–C); procumbent spine-like process (tip of 1st pterygiophore) apparent at origin of dorsal-fin but covered by predorsal scales.

Description. For the holotype and 5 paratypes, counts and proportional measurements as percentage of SL are given in Table 2. Data for the holotype are presented first, followed by non-type material (if different) in parentheses. Characters given in the diagnosis are not repeated.

Body deep, 45% of SL (42–55% of SL), relatively compressed, covered with ctenoid scales, ctenii free on posterior margin of exposed area; lateral line continuous until on hypural plate; orbit diameter slightly larger than interorbital space; suborbital depth

Table 2. Counts and proportional measurements, and characters as percentage of standard length of *Hapalogenys dampieriensis* sp. nov., *H. filamentosus* sp. nov., and *H. kishinouyei* (Smith and Pope, 1908)

	Hapalogenys dampieriensis sp. nov.			*Hapalogenys filamentosus* sp. nov.		*Hapalogenys kishinouyei*	
	Holotype CSIRO C4036-02	Paratypes* n=8	Non-type specimens *n*=17	Holotype MUFS 7666	Paratypes** *n*=3	Holotype USNM 55610	Non-type specimens *n*=39
Standard length (mm)	224	66–290	74–300	147	129–147	81	45–393
Dorsal-fin rays	XI, 14	XI, 13–14	XI, 13–14	XI, 14	XI, 14	XI, 14	XI, 14 (rarely 15)
Anal-fin rays	III, 9	III, 8–9	III, 8–9	III, 9	III, 9	III, 9	III, 9
Pectoral-fin rays	18	17–18	17–18	18	17–18	17	17–18
Pelvic-fin rays	I, 5	I, 5	I, 5	I, 5	I, 5	I, 5	I, 5
Pored lateral-line scales	44	41–45	41–45	41	41 or 42	45	44–47
Scale rows above and below lateral line	12 /20	10–12 / 20–23	10–12 / 20–23	11/22	10–11 / 20–22	11/23	11–13 / 23–25
Gill rakers including all rudiments	6 + 12	5–6 + 11–12	5–6 + 11–12	5 +11	5 + 11–12	7 +11	4–7 +11–13***
Scales on maxilla	absent	absent	absent	absent	absent	absent	absent
Scales on posterior and ventral aspects of angular	present	present	present	present	present	present	present
Body depth	45	42–55 (48)	74–300 (173)	147	115–149 (136)	50	44–53 (49)
Body depth at anal-fin origin	40	35–47 (41)	42–55 (48)	50	48–50 (49)	44	38–46 (42)
Head length	38	34–46 (41)	35–47 (42)	43	42–43 (42)	40	36–42 (38)
Body width	20	18–23 (20)	18-25 (20)	44	42–44 (43)	15	17–21 (19)
Snout length	13	14–16 (15)	13–16 (14)	19	16–20 (18)	12	12–17 (14)
Dermal eye opening	9	8–12 (10)	7–12 (10)	14	13–16 (14)	12	7–15 (8)
Orbit diameter	8	8–16 (12)	8–16 (11)	11	10–11 (11)	15	8–17 (10)
Suborbital depth	8	5–8 (7)	5–8 (7)	14	14 (14)	6	5–8 (7)
Interorbital width	9	8 (8)	8–9 (9)	8	7–8 (7)	7	8–10 (9)
Upper jaw length	15	15–16 (16)	15–16 (16)	10	8–10 (9)	15	14–16 (15)
Caudal-peduncle depth	12	11–13 (12)	11-13 (12)	16	15–16 (16)	13	11–13 (12)
Caudal-peduncle length	—	12–17 (16)	9–17 (13)	13	12–13 (13)	17	16–18 (17)
Predorsal length	39	38–49 (46)	38–49 (44)	17	17–18 (17)	46	40–49 (44)
Preanal length	70	71–77 (73)	69–77 (72)	49	45–49 (48)	67	67–74 (70)
Prepelvic length	46	40–52 (47)	39–52 (45)	69	69–74 (71)	42	39–48 (41)
Dorsal-fin base	56	54–59 (57)	54–62 (58)	41	41–48 (43)	60	55–62 (59)
Anal-fin base	17	13–17 (15)	13–20 (16)	61	57–61 (59)	18	15–20 (17)
Caudal-fin length	20	18–29 (25)	18–29 (24)	16	16–18 (17)	–	21–31 (25)
Pelvic-fin spine	13	12–19 (16)	12–19 (15)	27	27–28 (27)	20	13–18 (16)
First pelvic-fin ray	22	24–31 (29)	21–31 (27)	20	18–21 (20)	32	22–31 (25)
Longest pectoral-fin ray	22	19–32 (28)	19–32 (26)	34	30–35 (33)	26	23–31 (26)
First dorsal-fin spine	4	4–9 (7)	4–9 (6)	30	30–32 (31)	6	4–9 (6)
Second dorsal-fin spine	9	7–16 (12)	7–16 (11)	10	7–10 (8)	17	6–16 (12)
Third dorsal-fin spine	15	14–24 (19)	13–24 (18)	18	13–18 (15)	24	15–24 (20)
Fourth dorsal-fin spine	17	14–27 (22)	14–27 (20)	26	22–26 (24)	28	17–26 (22)
Fifth dorsal-fin spine	15	13–27 (21)	13–27 (19)	25	25–28 (26)	26	17–25 (21)
Last dorsal-fin spine	5	3–11 (8)	3–11 (6)	23	23–27 (24)	15	6–11 (8)
First dorsal-fin ray	12	13–24 (14)	6–20 (13)	10	10–11 (10)	–	14–19 (17)
Second dorsal-fin ray (longest)	16	13–22 (18)	13–22 (16)	19	17–20 (19)	–	16–21 (19)
First anal-fin spine	7	5-11 (9)	13–24 (17)	21	20–23 (21)	–	24 (24)
Second anal-fin spine	17	13–24 (20)	4–11 (7)		23 (23)	10	6–11 (8)
Third anal-fin spine	13	10–15 (13)	13–24 (18)	10	9–10 (10)	21	14–20 (18)
First anal-fin ray	15	13-23 (19)	12–23 (16)	23	22–24 (23)	15	9–14 (12)
Second anal-fin ray	14	11–20 (18)	11–21 (16)	15	14–16 (15)	21	16–24 (19)

*Paratypes, AMS I.22805-035 (2 specimens) and NTM 13547-002, 13523-008, S.13551-003 and 13569-010 (3 specimens); **Paratypes, MUFS 7654, 7667–7668, 3 specimens; ***Upper and lower gill raker counts decrease with growth from 6 or 7 to 4 or 5 and from 12 or 13 to 11 or 12, respectively.

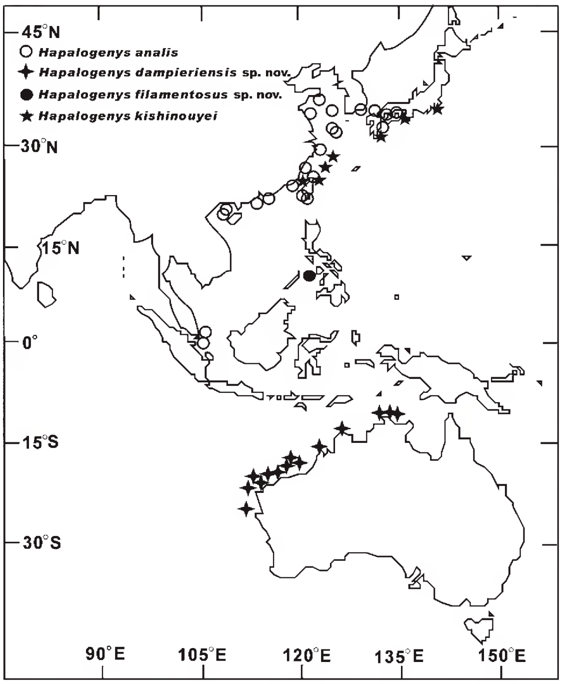

Figure 5. Distribution of 4 *Hapalogenys* species: *Hapalogenys analis*, *Hapalogenys dampieriensis* sp. nov., *Hapalogenys filamentosus* sp. nov. and *Hapalogenys kishinouyei.*

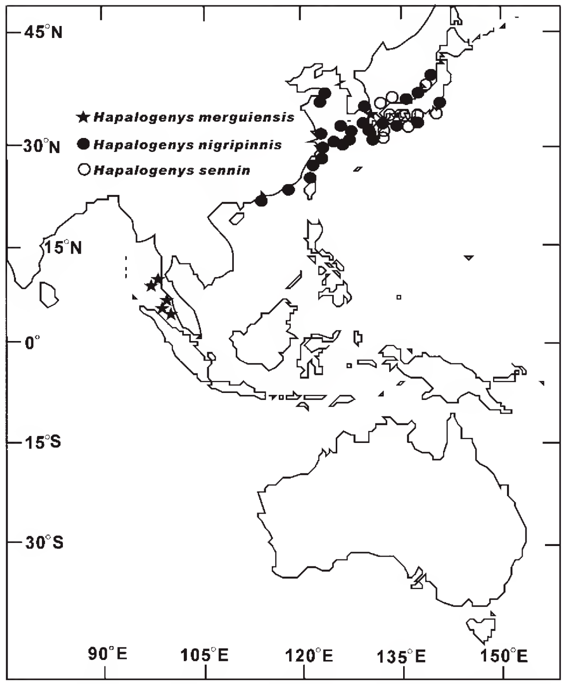

Figure 6. Distribution of 3 *Hapalogenys* species: *Hapalogenys merguiensis*, *H. nigripinnis* and *H. sennin.v*

distinctly less than eye diameter; head covered with scales, extending almost to snout tip; lips, chin and ventral part of urohyal naked; cheek and opercle fully scaled; jaws with bands of pointed conical teeth, outermost teeth generally enlarged, but not forming canines; teeth absent on vomer and palatines; preopercle serrate; upper opercle with 2 short spines posteriorly; single notched dorsal-fin; 4th dorsal-fin spine and 2nd dorsal-fin ray longest; 1st dorsal- and anal-fin soft rays not strongly bifurcated; 1st anal-fin spine short, 2nd very robust, longest, clearly longer than 3rd; dorsal and anal fins with high scaly sheath; caudal fin rounded in juveniles, becoming truncate with growth.

Live colouration. Based on a colour photograph in Gloerfert-Tarp and Kailola, 1984: 2nd upper left figure on p. 196, registered as CSIRO CA1552, 270 mm SL, from north-western Australia – specimen not seen by us and CSIRO C4036-02, holotype, 234 mm SL: head and body generally pale silvery bronze, usually lighter than in *H. kishinouyei* (figs 1B, 1E, and 2A–F); dorsal and anal fins translucent or pale brownish; soft dorsal fin pale; pelvic-fin rays and membranes dusky; pelvic-fin spine dark-brownish; iris golden-brown; lips, lower parts of cheek, preopercle, and interopercle pale-brownish.

Preserved colouration. Based on all type specimens: head and body generally dark-brownish; 4 narrow longitudinal brownish pale-brown dark stripes (2nd and 3rd stripes most distinct) in specimens smaller than about 100 mm SL, 2nd and 3rd stripes only present in larger specimens, their width below base of 5th and 6th dorsal-fin spines narrower than pupil diameter (see figs 2A–C in 65–158 mm SL and fig. 1B); pelvic-fin rays, including membrane, dusky; pelvic-fin spine pale-brown; iris, lips, ventral portion of cheek, preopercle, and interopercle brown.

Distribution. Hapalogenys dampieriensis sp. nov. is currently known only from north-western Australia (see fig. 5) in depths of 87–230 m. The species is likely to have a continuous distribution in similar depths between known localities.

Ecological note. The specific habitat at the collection sites of the type specimens is uncertain, but likely to be dominated by a muddy rocky bottom, similar to that of *H. kishinouyei.*

Etymology. The name "*dampieriensis*" refers to the Dampierian Province (named after the explorer William Dampier), a biogeographic region extending from approximately Geraldton in Western Australia across northern Australia to Cape York, approximating the distribution of the new species in Australia.

Remarks. The largest recorded size of *H. dampieriensis* sp. nov. is 300 mm SL (NTM S12819-002), compared with more than 500 mm SL for *H. kishinouyei.*

Hapalogenys filamentosus sp. nov.

New English name: Philippines Dark Velvetchin

Figures 1C–D, 3E–F

Type material. Holotype: MUFS 7666, 147 mm SL, off Iloilo, Panay I., Philippines, 10 Mar 1981, bottom trawl, 30–80 m, coll. M. Akazaki. Paratypes: MUFS 7654, 149 mm SL, off Iloilo, Panay I., Philippines, bottom trawl, about 40 m depth, 11 Mar 1981, coll. M. Akazaki; MUFS 7667–7668, 2: 129–143 mm SL, same data as holotype.

Diagnosis. A species of *Hapalogenys* with the following combination of characters: fleshy lower lip with dense cluster of very short papillae (figs 3E–F), scaly posteriorly (on posterior abdominal part of angular of lower jaws, (fig. 3F); 10 unobstructed pores on and behind chin (fig. 3F; see Gloerfelt-Tarp and Kailola, 1984:197, fig. 2); no scales on maxilla (fig. 3E); 2 faint longitudinal dark stripes on body, 1st from nape to base of mid dorsal-fin soft rays, 2nd from eye to base of last dorsal-fin soft ray, their width below base of 5th and 6th dorsal-fin spines clearly narrower than pupil diameter (see figs 2A–C in 65–158 mm SL and fig. 1B); soft rayed portions of dorsal and anal fins somewhat rounded posteriorly and slightly angulated posteriorly, respectively (fig. 1C); pelvic-fin tip almost reaching to or slightly beyond base of 1st anal-fin spine when depressed (figs 1C–D); 41 or 42 pored lateral-line scales; a procumbent spine-like process (exposed tip of 1st pterygiophore) apparent at origin of dorsal fin but covered by predorsal scales.

Description. Counts and proportional measurements as percentage of SL of the holotype and 5 paratypes are given in Table 2. Data for the holotype are presented first, followed by paratype material (if different) in parentheses. Characters given in the diagnosis are not repeated.

Body deep, 50% of SL (45–55% of SL), relatively compressed, covered with ctenoid scales, ctenii free on posterior margin of exposed area; lateral line continuous until on hypural plate; orbit diameter slightly larger than interorbital space; suborbital depth clearly less than eye diameter; head covered with scales, extending almost to snout tip; lips, chin and ventral part of urohyal naked; cheek and opercular bones fully scaled; jaws with bands of pointed conical teeth, outermost teeth generally much enlarged but no distinct canines; teeth absent on vomer and palatines; preopercle serrate; upper opercle with 2 short spines posteriorly; single notched dorsal fin; 4th dorsal-fin spine and 2nd dorsal-fin ray longest; 1st dorsal- and anal-fin soft rays not strongly bifurcated; 1st anal-fin spine short, 2nd very robust, longest, clearly longer than 3rd; dorsal and anal fins with high scaly sheath; pectoral-fin tip not reaching to vertical at anus or pelvic-fin tip when depressed; caudal fin slightly rounded.

Preserved colouration. Based on all type specimens: head and body generally dark-brownish; 2 faint longitudinal stripes on head and body.

Distribution. Hapalogenys filamentosus sp. nov. is currently known only off Iloilo, Panay I., Philippines. Efforts by the first author to collect other examples of the species from fish markets and trawl catches throughout the Philippine Is. (Luzon, Mindoro, Panay, Cebu and Mindanao Is.) have been in vain. Apart from the type specimens, no examples are known to exist in museum collections.

Ecological note. The habitat of *H. filamentosus* sp. nov. is likely to be similar to that of *H. kishinouyei* and *H. dampieriensis* sp. nov.

Etymology. The name "*filamentosus*" refers to the filamentous 1st ray of the pelvic fin in this species.

Hapalogenys kishinouyei Smith and Pope, 1906

English name: Striped Velvetchin
Japanese Name: Shimasetodai

Figures 1E, 2D–F, 3G–H

Hapalogenys kishinouyei Smith and Pope, 1906: 476, fig. 6 (type locality: Urado, Kanagawa, Japan).–Jordan and Thompson, 1912: 554, fig. 3 (Tokyo).–Izuka and Matsuura, 1920:150 (Takamatsu, Kagawa, Japan).–Fowler, 1931: 269 [Urado, Kanagawa and Takamatsu, Kagawa, Japan, Philippines (doubtful locality)].–Kyushin et al.,1982: 102 (South China Sea).–Akazaki, 1984: 173 (East Asian Shelf).–Okamura et al., 1985: 489, 678 (Okinawa Trough).–Chen et al., 1997: 102, fig. 306 (South China Sea).–Iwatsuki et al., 2000a: 133 (East Asian Shelf and Australian specimens now referred to *H. dampieriensis* sp. nov.).–Shimada, 2000: 841 [southern Japan, Philippines (doubtful locality), and north-west Australian specimens now referred to *H. dampieriensis* sp. nov.)].–Randall and Lim, 2000: 619 (South China Sea).–Shinohara et al., 2001: 326 (Tosa Bay, Japan).–Shimada, 2002: 841 [southern Japan, Philippines (doubtful locality) and north-west Australian specimens now referred to *H. dampieriensis* sp. nov.].–Youn, 2002: 339, 613 (Korea).

Type material. Holotype: USNM 55610, 81 mm SL, Tokyo, Japan (see fig. 2D).

Non-type material. 45–393 mm SL, *n*= 39. MUFS 770, 235 mm SL, Osaka Fish Market, Japan; MUFS 12316, 12343, 164–264 mm SL, Meitsu, Nango, Miyazaki, Japan, set net, about 25 m; MUFS 12421, 338 mm SL, Ooshima I., Meitsu, Nango, Miyazaki, Japan, large set net, about 50 m depth; MUFS 12589, 45 mm SL, off Kihachi, Miyazaki, Japan; MUFS 12852–12854, 3: 242–268 mm SL, Meitsu, Nango, Miyazaki, Japan, set net, about 50 m; MUFS 14041, 14286, 153–168 mm SL, Meitsu, Nango, Miyazaki, Japan; MUFS 14937, 145 mm SL, Meitsu, Nango, Miyazaki, Japan; MUFS 16351, 262 mm SL, Meitsu, Nango, Miyazaki, Japan; SFU 1325, 133 mm SL, Shanghai, China; SFU Chingtao, China; SFU South China Sea; SFU 58-2573, 183 mm SL, China; SFU 63-0092, 187 mm SL, China; SFU 3858, 147mm SL, Taiwan Strait, China; URM-P 28055, 221 mm SL, East China Sea; URM-P 28056, 207 mm SL, East China Sea near Taiwan.

Diagnosis. A species of *Hapalogenys* with the following combination of characteristics: fleshy lower lip with dense cluster of very short papillae (figs 3G–H), scaly posteriorly (on posterior abdominal part of angular of lower jaws, fig. 3H); 10 pores on and behind chin, including a single very small pore near symphysis, plus 2 moderately-sized pores anteroventrally on each dentary, a single large pore ventrally at midpoint of dentary, and a single large pore ventrally at midpoint of angular (2 posteriormost pores sometimes slit-like) (see Gloerfelt-Tarp and Kailola, 1984:197, fig. 2); no scales on maxilla (fig. 3G); 5 broad distinct longitudinal stripes, 1st from front of 1st dorsal-fin spine along dorsal midline, 2nd from nape to base of mid dorsal-fin soft rays, 3rd from eye to last dorsal-fin ray base, 4th from preopercular flange, through base of pectoral fin, to lower caudal peduncle,

last from isthmus to base of anal spinous fin; the 1st, 4th and 5th stripes lost in specimens larger than about 250 mm SL (figs 1E, 2D–F) and their width below base of 5th and 6th dorsal-fin spines clearly greater than pupil diameter at all sizes; soft rayed portions of dorsal and anal fins somewhat rounded posteriorly and somewhat angulated posteriorly, respectively (figs 1E, 2D–F); pelvic-fin tip extending slightly beyond anus but clearly not reaching to base of 1st anal-fin spine when depressed (figs 1E, 2D–F); 44–47 pored lateral-line scales; a procumbent spine-like process (exposed tip of 1st pterygiophore) at origin of dorsal.

Description. Counts and proportional measurements as percentage of SL of the holotype and 5 paratypes are given in Table 1. Data for the holotype are presented first, followed by non-type material (if different) in parentheses. Characters given in the diagnosis are not repeated.

Body deep, 49% of SL (44–53% of SL), relatively compressed, covered with ctenoid scales, ctenii free on posterior margin of exposed area; lateral line continuous until on hypural plate; orbit diameter clearly larger than interorbital space; suborbital depth clearly less than eye diameter; head covered with scales, extending almost to anterior nostrils; chin and ventral part of urohyal naked; cheek and opercular bones fully scaled; jaws with bands of pointed conical teeth, outermost teeth generally much enlarged but no distinct canines; teeth absent on vomer and palatines; preopercle serrate; upper opercle with 2 short spines posteriorly; single notched dorsal fin; 4th dorsal-fin spine longest; 1st dorsal- and anal-fin soft rays not strongly bifurcated; 1st anal-fin spine short, 2nd anal fin longest, clearly longer than 3rd; dorsal and anal fins with high scaly sheath; pectoral-fin tip not reaching to vertical at anus or pelvic-fin tip when depressed; caudal fin generally truncate.

Live colouration. Based on colour photographs of specimens (MUFS 20896, 14286): head and body generally dark-brownish, slightly lighter on jaws; dorsal, anal and pectoral fins dark-brownish (similar to body); pelvic-fin rays and membranes black; pelvic-fin spine dark-brownish; iris brownish-golden (orange-golden); lips, lowest parts of cheek and preopercle, and interopercle pale-brownish.

Preserved colouration. Based on the holotype and non-type specimens: head and body generally dark-brownish; 5 longitudinal stripes on body; pelvic-fin rays with black membrane, pelvic-fin spine pale-brown; iris, lips, ventral portion of cheek and preopercle, and interopercle brown.

Distribution. Hapalogenys kishinouyei is currently known only from the East Asian Shelf (fig. 5).

Biological note. The largest specimen of *Hapalogenys kishinouyei* studied was 556 mm SL, collected from a set net catch at Meitsu fish market, Nango, Miyazaki, Japan on 14 Nov 1994 (specimen not kept). This species commonly reaches 150–300 mm SL.

Remarks. Although Fowler, 1931 reported *Hapalogenys kishinouyei* from the Philippines and adjacent regions, the species was originally based on specimens from Urado, Tokyo, and Takamatsu, Kagawa, Japan. Despite subsequent reports including the Philippines in the species' distribution (Iwatsuki et al., 2000a; Shimada, 2000, 2002), attempts by us to locate *H. kishinouyei* specimens in fish markets and museum collections over the past ten years have been unsuccessful in documenting any Philippine occurrences of this species. This strongly suggests that the species is not distributed in the Philippines. However, Chen et al., 1997 provided a fine colour plate of the species from the South China Sea and van Quan (unpublished document) listed the species from northern Vietnam.

Hapalogenys merguiensis Iwatsuki, Satapoomin and Amaoka, 2000

New English name: Mergui Velvetchin

Figures 1F, 4A–B

Hapalogenys merguiensis Iwatsuki, Satapoomin and Amaoka, 2000a: 133, fig. 1A–C (type locality: Mergui Basin, southern Myanmar Sea, Andaman Sea).

Type material. Holotype: HUMZ 90021, 242 mm SL, Mergui Basin, southern Myanmar Sea (11°27'N, 97 °16'E). Paratypes (174–242 mm SL, *n*=6): AMS I. 22739-001, 192 mm SL, southern Andaman Sea, off Satun Province near Phuket, W coast of southern Thailand; HUMZ 90022, 178 mm SL, same data as holotype; MUFS 15800, 177 mm SL, Taninthayi Coast, southern Myanmar Sea; PMBC 10985, 199 mm SL, off Satun Province near Phuket, W coast of southern Thailand, southern Andaman Sea; PMBC 10986, 179 mm SL, southern Andaman Sea, off Satun Province near Phuket, W coast of southern Thailand.

Non-type material. HUMZ 33397, 172 mm SL, Andaman Sea.

Diagnosis. A species of *Hapalogenys* with the following combination of characters: fleshy lower lip with dense cluster of very short papillae and barbels (figs 4A–B), slightly scaly posteriorly (fig. 4B); 10 pores on and behind chin, including a single very small pore near symphysis, plus 2 moderately-sized pores anteroventrally on each dentary, a single large pore ventrally, at midpoint of dentary, and a single large pore ventrally at midpoint of dentary and angular (2 posteriormost pores sometimes slit-like) (see Gloerfelt-Tarp and Kailola, 1984:197, fig. 2); no scales on maxilla (fig. 3A); 2 indistinct oblique dark bands, 1st descending from nape to behind pectoral fin, and 2nd from base of anterior 2nd or 3rd dorsal-fin spine and soft dorsal-fin base, curving backwards through lateral line to soft anal fin and caudal peduncle (1 whitish or indistinct pale brown oblique band, curving backward and becoming wider, from base of first 3 dorsal-fin spines, to anus and spinous anal-fin base) (fig. 1F); soft rayed portions of dorsal and anal fins rounded posteriorly and somewhat truncate posteriorly, respectively (fig. 1F); pelvic-fin tip not reaching to 1st anal-fin spine when depressed (fig. 1F); 39–42 pored lateral-line scales; a procumbent spine-like process (exposed tip of 1st pterygiophore) at origin of dorsal fin.

Description. A detailed description was given by Iwatsuki et al., 2000a and is not repeated here.

Distribution. Hapalogenys merguiensis is currently known only from the Andaman Sea, in depths from about 80–180 m (see Iwatsuki et al., 2000a).

Hapalogenys nigripinnis Schlegel in Temminck and Schlegel, 1843

New English name: Short Barbeled Velvetchin
Japanese name: Higesoridai

Figures 1G, 4C–D

Pogonias nigripinnis Schlegel in Temminck and Schlegel, 1843: 59, pl. 25 (type locality: Nagasaki Bay, Nagasaki, Japan).

Hapalogenys nitens Richardson, 1844b: 84, pl. 43, figs 1–2 (type locality: Canton, China).–Richardson, 1844a: 463 (Macao, China).

Hapalogenys aculeatus Nyström, 1887: 10 (type locality: Japan).

Hapalogenys guentheri Matsubara, 1933 (originally *güntheri*): 86, fig. 6 (type locality: Pusan, South Korea).

Type material. Lectotype: RMNH D282, 292 mm SL, Nagasaki Bay, Nagasaki, Japan. Paralectotpes: RMNH D283 (dried), 245 mm SL, RMNH D284 (dried), 206 mm SL, RMNH 722, 240 mm SL, RMNH D2216 (dried), 347 mm SL, ZMB 8121 (dried), 198 mm SL, all as Nagasaki, Japan.

Non-type material. BMNH 1968.3.11.1 (holotype of *Hapalogenys nitens*), 107 mm SL, Canton, China; FAKU 51028–51029 (holotype and paratype of *Hapalogenys guentheri*, [originally *güntheri*]), 2: 205 mm SL and 138 mm SL, respectively, Pusan, Korea, holotype coll. date unknown, paratype coll. 30 Apr. 1927; ZMUU 275 (holotype of *Hapalogenys aculeatus*), 320 mm SL, Nagasaki, Japan. 43 other specimens examined (53–404 mm SL) are listed in Iwatsuki and Nakabo, 2005.

Diagnosis. A species of *Hapalogenys* with the following combination of characters: fleshy lower lip with dense cluster of very short papillae and barbels (figs 4C–D), scaly posteriorly (on posterior abdominal part of angular of lower jaws, fig. 4D); 10 pores on and behind chin, including a single very small pore near symphysis (usually not apparent owing to dense covering papillae), plus 2 moderately-sized pores anteroventrally on each dentary, a single large pore ventrally at midpoint of dentary, and single large pore ventrally at articulation of dentary and angular (2 posteriormost pores usually slit-like concave traces or slit-like) (see figs 4C–D; Gloerfelt-Tarp and Kailola, 1984: 197, fig. 2); scales on maxilla (fig. 4C); body often with 2 indistinct oblique dark bands, 1st descending from nape to behind pectoral fin and running to posterior part of soft anal-fin rays, 2nd descending from base of anterior 3rd or 4th dorsal-fin spines and soft dorsal-fin base, curving backwards through lateral line to upper part of caudal peduncle (fig. 1G, often uniformly dark or pale-brown); soft rayed portions of dorsal and anal fins strongly rounded posteriorly and slightly angulated posteriorly, respectively (fig. 1G); pelvic-fin tip not reaching to base of 1st anal-fin spine when depressed (fig. 1G); 45–48 (rarely 44 or 49) pored lateral-line scales; a procumbent spine-like process (exposed tip of 1st pterygiophore) almost completely hidden by predorsal scales at origin of dorsal fin.

Description. A detailed description was given by Iwatsuki et al., 2000a and is not repeated here.

Distribution. Hapalogenys nigripinnis is currently known only from the East Asian Shelf in depths less than 100 m (see Iwatsuki and Nakabo, 2005; see fig. 6). The species has not been confirmed as occurring around the Ryukyu or Ogasawara Is., or southern Japan.

Remarks. The status of *H. aculeatus* Nyström, 1887, *H. nitens* Richardson, 1844b and *H. guentheri* Matsubara, 1933 (originally *H. güntheri*) as junior synonyms of *H. nigripinnis* Schlegel in Temminck and Schlegel, 1843, was discussed by Iwatsuki and Nakabo, 2005.

Hapalogenys sennin Iwatsuki and Nakabo, 2005

New English name: Long Barbeled Velvetchin
Japanese name: Higedai

Figures 1H, 3E–F

Hapalogenys sennin Iwatsuki and Nakabo, 2005: 861 (type locality: Meitsu, Miyazaki, Japan).

Type material. Holotype: MUFS 11649 (fig. 1H), 232 mm SL, Meitsu, Nango, Miyazaki, Kyushu I., Japan (31°31.9'N, 131°23.5'E), set net, less than 30 m depth. Paratypes (*n*=13, all from Japan): FAKU 38698, 234 mm SL, Oki I., Shimane; FAKU 85960, 227 mm SL, Tateyama, Chiba, Boso Peninsula; FRLM 3715, Shima-cho, Shima-gun, Mie; KPM-NI 49, 208 mm SL, Kanagawa; MUFS 2086, 176 mm SL, Miyazaki fish market, Miyazaki, Japan; MUFS 7149, 68 mm SL, mouth of the Kaeda R., Miyazaki, Japan; MUFS 11678, 207 mm SL, female, Meitsu, Nango, Miyazaki; MUFS 14627, 79 mm SL, mouth of the Kaeda R., Miyazaki; MUFS 16060, 248 mm SL, Shirahama, Wakayama; MUFS 20810, 194 mm SL, Moroyose, Hyogo, Sea of Japan; MUFS 21573, 296 mm SL, female, Meitsu, Nango, Miyazaki; MUFS 22226, 46 mm SL, Hitotsuba Inlet, Ooyodo R., Miyazaki; NSMT-P 60236, 174 mm SL, Suzaki, Chiba; OMNH-P 2682, 183 mm SL, Moroyose, Hyogo, Sea of Japan, set net.

Non-type material. 21 specimens examined (49–296 mm SL, all from Japan) are listed in Iwatsuki and Nakabo, 2005.

Diagnosis. A species of *Hapalogenys* with the following combination of characters: fleshy lower lip with dense cluster of long and short papillae and barbels on chin (figs 4E–F), not scaly posteriorly (on posterior abdominal part of each angular of lower jaws, fig. 4F); 10 pores on and behind chin (only 4 slit-like pores on angular on each lower jaw in young and then becoming covered in adults; fig. 4F); no scales on maxilla (fig. 4E); 2 faint oblique dark bands on body, 1st descending from nape to behind pectoral fin and then running to posterior part of soft anal-fin rays, and 2nd from base of anterior 3rd or 4th dorsal-fin spines and soft dorsal-fin base, curving backward through lateral line to upper part of caudal peduncle, or often becoming uniform dark-brown on body (fig. 4E–H of Iwatsuki and Nakabo, 2005); soft rayed portions of dorsal and anal fins strongly angulated posteriorly (fig. 1H, anal more strong angulated than dorsal); pelvic-fin tip not reaching to base of 1st anal-fin spine when depressed (fig. 1H); 44–45 (rarely 43 or 46) pored lateral-line scales; a procumbent spine-like process (exposed tip of 1st pterygiophore) at origin of dorsal fin, sometimes hidden by predorsal scales.

Description. A detailed description was given by Iwatsuki and Nakabo, 2005 and is not repeated here.

Distribution. Hapalogenys sennin is currently known only from the southern part of Japan (excluding the Ryukyu and Ogasawara Is.) and is possibly endemic to the Japanese region (fig. 6; see Iwatsuki and Nakabo, 2005).

Ecological notes. Collection data indicate that habitat of *Hapalogenys sennin* is restricted to river mouths and coastal rocky-sandy bottoms in depths of less than 50 m. Detailed habitat features are given in Iwatsuki and Nakabo, 2005.

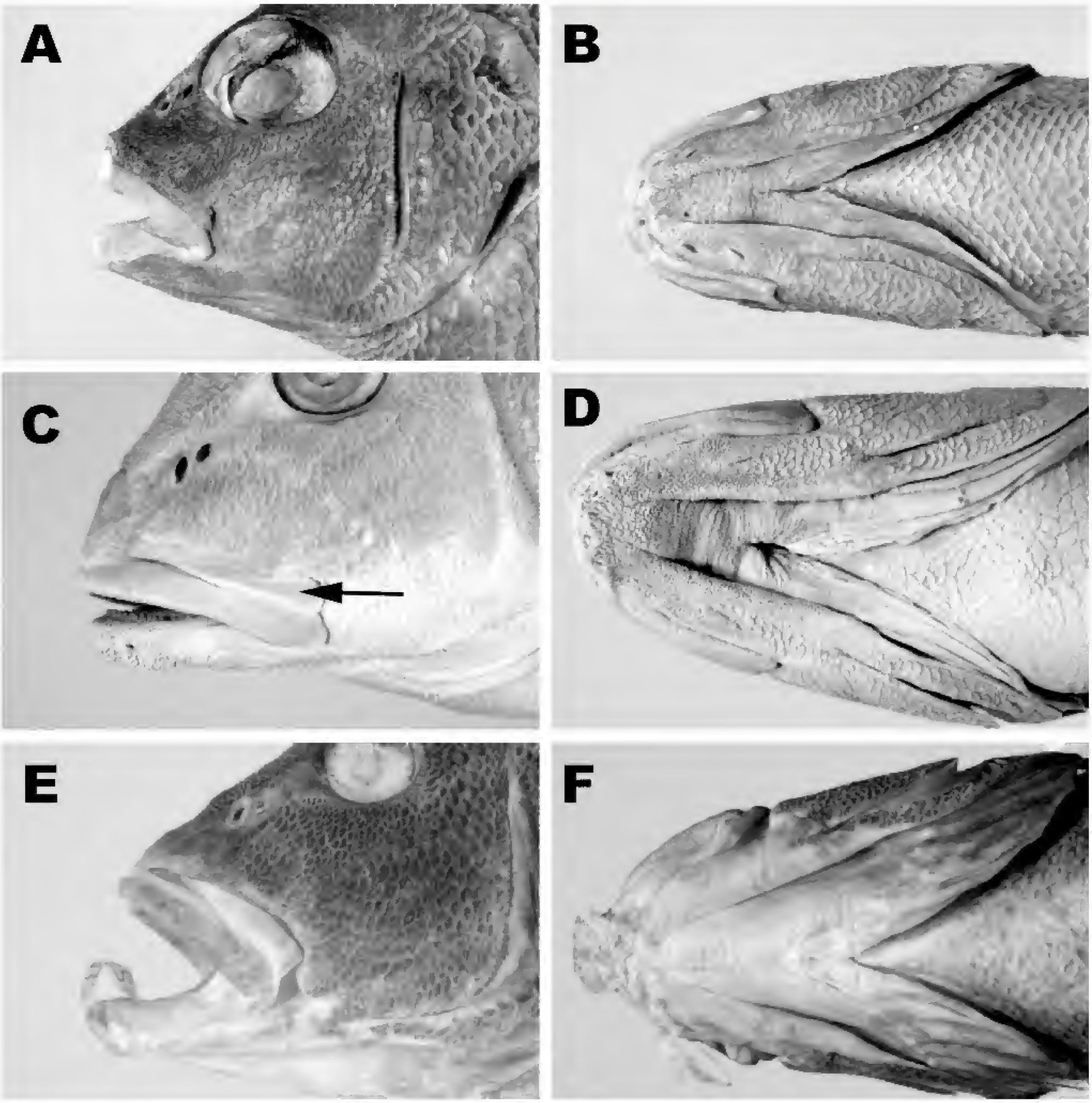

Figure 4. Head (left) and lower jaw ventral view (right) of 3 species, *Hapalogenys merguiensis* (A–B), *H. nigripinnis* (C–D) and *H. sennin* (E–F). A–B), HUMZ 33397, 172 mm SL, Andaman Sea; C–D), ZMUU 275, holotype of *H. aculeatus*, 320 mm SL, Nagasaki, Japan; E–F), MUFS 11649, holotype, 232 mm SL, Meitsu, Nango, Miyazaki, Japan. Arrow indicates squamation on maxilla.

Discussion

Iwatsuki et al., 2000a demonstrated that *Hapalogenys maculatus* Richardson, 1846, from Canton, China, should be considered as a "*nomen dubium*", because the seven presently known valid species of *Hapalogenys* all lack the round spots on the upper half of the body, tail and vertical fins that supposedly characterise *H. maculatus*. The description of *H. maculatus* is highly suggestive of *Plectorhinchus cinctus* Schlegel in Temminck and Schlegel, 1843, a haemulid (Iwatsuki et al. 2000a).

Other nominal species previously placed in *Hapalogenys* include: *Hapalogenys meyenii* Peters (synonymized under *Parapristipoma trilineatum* Thunberg by Iwatsuki et al., 2000b); *Hapalogenys petersi* Day (subsequently removed to the genus *Dinoperca,* and assigned to a new family Dinopercidae, by Heemstra and Hecht, 1986); and *Hapalogenys pictus* Tortonese (transferred to *Plectorhinchus* by Smith, 1962). In addition, the holotype (ZMB 10179, 215 mm SL) of *H. atlanticus* Reichenow from Chinchoxo (= Chichoua), Gabon, West Africa, was shown to be a senior synonym of *Centrarchops chapini* Fowler by Heemstra and Iwatsuki (in press). *Hapalogenys nigripinnis* Schlegel in Temminck and Schlegel, 1843 was shown to be a senior synonym of *H. nitens* Richardson, 1844b, *H. aculeatus* Nyström, 1887 and *H. guentheri* Matsubara, 1933, by Iwatsuki and Nakabo, 2005. Accordingly, we recognise seven valid *Hapalogenys* species, including two new species: *H. analis*, *H. dampieriensis* sp. nov., *H. filamentosus* sp. nov., *H. kishinouyei*, *H. merguiensis*, *H. nigripinnis* and *H. sennin* (figs 1A–H and t 3).

Table 3 includes selected characters of the above seven *Hapalogenys* species. All have the following combination of characters: dorsal-fin rays X or XI, 13–17, anal-fin rays III, nine or ten, relatively deep body, a procumbent spine-like process (exposed tip of first pterygiophore) at origin of dorsal fin, ten pores (total) on and behind chin, including a single very small pore near symphysis plus four pores on each lower jaw, and a cluster of very short dense barbels and/or papillae on the fleshy lower lip (figs 3–4; Iwatsuki et al., 2000a).

Hapalogenys analis differs from other congeners in having five to seven alternating whitish and dark-brown bands on the head and body (fig. 1A), a black margin posteriorly on the dorsal-, anal- and caudal-fin soft rays (fig. 1A), black membrane on the spinous dorsal- and anal-fin (until first anal-fin ray), and pelvic-fin rays (fig. 1A), and well-developed papillae and barbels on the fleshy lower lip (figs 1A, 3A–B). Other congeners lack these characters (figs 1B–H). *Hapalogenys nigripinnis* and *H. sennin* differ from other *Hapalogenys* species in having vertical and longitudinal stripes on the body (fig. 1B–H), higher counts of pored lateral-line scales (usually 44–48 vs. 44–45; Table 3). In addition, *H. sennin* has extremely well-developed papillae and barbels on the fleshy lower lip with a dense cluster on the chin (fig. 4F). *Hapalogenys nigripinnis* differs from the latter in having scales on the maxilla (vs. absent in *H. sennin*; fig. 4C, E) and rounded soft dorsal fin posteriorly (vs. strongly angulated in *H. sennin*; fig. 1G, 1H).

Hapalogenys dampieriensis sp. nov., *H. filamentosus* sp. nov. and *H. kishinouyei* are similar to each other in overall appearance and are accordingly identified as the "*Hapalogenys kishinouyei* complex", a species group defined by having two to five longitudinal stripes on the body. However, *H. dampieriensis* sp. nov. differs from the two other species in having four narrow dark longitudinal stripes, two of which are lost in adults (figs 2A–C in 65–158 mm SL and fig. 1B in about 270 mm SL). In contrast, *H. kishinouyei* has five (only two in adults) broad dark longitudinal stripes on the body (figs 2D–F in 81–168 mm SL and fig. 1E in 266 mm SL), and *H. filamentosus* has two faint narrow longitudinal body stripes, the filamentous pelvic-fin ray almost reaching to or slightly beyond base of first anal-fin spine when depressed (vs. slightly beyond anus but not reaching to first anal-fin spine base in *H. dampieriensis* and *H. kishinouyei*; figs 1C, D). Furthermore, *H. filamentosus* differs from *H. dampieriensis* sp. nov. in having the posteriormost angle of the jaw reaching to a vertical through the centre of the eye (vs. the jaw reaching slightly beyond a vertical through the anteriormost eye membrane in *H. dampieriensis* sp. nov. and *H. kishinouyei* in similar sized specimens of 130–160 mm SL, fig. 1C and figs 2B–C, 2E–F).

Randall, 1981 reported many marine antitropical and anti-equatorial species from the Indo-Pacific, and the distribution of the genus *Hapalogenys* itself also seems to be generally anti-tropical (figs 5–6; Randall, 1981). *Hapalogenys analis, H. kishinouyei, H. nigripinnis* and *H. sennin* have sympatric distributions and occur essentially in the same areas, viz. "East Asian Shelf", except off the Ryukyu and Ogasawara Is. However, within this general area the collection data indicate they occupy different niches.

Hapalogenys kishinouyei is distributed in depths less than 200 m along the Pacific coast of Japan from Boso Peninsula, Honshu I., through the southernmost Shikoku and Kyushu Is.; the East China Shelf slope from Senkaku I. to southern Kyushu; and in the South China Sea. *Hapalogenys analis* is distributed in the East China Sea (including western Japan) and South China Sea in shallow coastal waters, in depths less than 100 m. *Hapalogenys nigripinnis* is densely distributed off southern Japan (except the Ryukyu and Ogasawara Is.), southern Korea, East China Sea, Taiwan Strait and Hong Kong, in depths less than 50 m (Iwatsuki and Nakabo, 2005). *H. sennin* is generally distributed off southern Japan (except the Ryukyu and Ogasawara Is.) and inhabits shallow coastal rocky and sandy shores in depths less than about 30 m during spring and autumn (unknown in winter; Iwatsuki and Nakabo, 2005). By comparison, *H. dampieriensis* sp. nov., *H. filamentosus* sp. nov. and *H. merguiensis* have allopatric distributions and occur off north-western Australia, the Philippines (off Iloilo, Panay I.), and in the Andaman Sea, respectively.

Comparative material examined. *Centrarchops chapini*: ZMB 10179 (holotype of *Hapalogenys atlanticus*), 215 mm SL, Chinchoxo (=Chichoua), Gabon, west Africa *Parapristipoma trilineatum*: ZMB 1050 (holotype of *Hapalogenys meyenii*), 340 mm SL, Manila, Philippines.

Table 3. Selected characters of 7 species of the genus *Hapalogenys*

	*H. analis** 72–201 mm SL (*n*=50)	*H. dampieriensis* sp. nov. 66–300 mm SL (*n*=26)	*H. filamentosus* sp. nov. 115–149 mm SL (*n*=4)	*H. kishinouyei* 45–393 mm SL (*n*=40)	*H. merguiensis* 172–242 mm SL (*n*=7)	*H. nigripinnis* 54–404 mm SL (*n*=59)	*H. sennin* 49–292 mm SL (*n*=36)
Dorsal-fin rays	XI, 15–16	XI, 13–14	XI, 14	XI, 14 (rarely 15)	XI, 14	XI, 15-16	XI, 16–17 (rarely 18)
Anal-fin rays	III, 9 (rarely 10)	III, 8–9	III, 9	III, 9	III, 9–10	III, 9 (rarely 10)	III, 9–10
Pectoral-fin rays	18–19 (rarely 20)	17–18	17–18	17–18	17–18	18–20	17–18
Gill rakers	6–7 + 13–14	5–6 + 11–12	5 + 12	4–7 + 11–13	5–7 + 12-13	5–6 (rarely 7) + 12–13	5–6 + 12–14
Pored lateral-line scales	usually 44–47 but rarely 43 or 48	41–45	41 or 42	44–47	39–42	45–48 (rarely 44 or 49)	44–45 (rarely 43 or 46)
Scale rows above and below lateral line	10–14 (rarely 9) /22–24 (rarely 21)	10–12/21–23	10–11/20	11–13/23–25	9–10/18–20	12–14/22–25	9–11/15–17
A procumbent spine-like process (exposed tip of 1st pterygiophore) at origin of dorsal fin	apparent	apparent	apparent	apparent	apparent	apparent; rarely not apparent in smaller specimens of ca. 100 mm SL	usually not apparent; hidden by dorsal scales
Papillae and barbels on fleshy lower lip	developed	poorly developed	poorly developed	poorly developed	developed	developed	extremely well-developed but like a dense cluster
Scales on maxilla	present	absent	absent	absent	absent	present	absent
Scales on posterior abdominal part of angular of lower jaws	present	present	present	present	present	present	absent
1st soft pelvic-fin ray	not filamentous	weakly filamentous	extremely filamentous	not filamentous	not filamentous	not filamentous	not filamentous
Tip of first pelvic-fin ray (when depressed)	not reaching to base of first anal-fin spine	extending slightly beyond anus but not to first anal-fin spine base	almost reaching to or slightly beyond base of first anal-fin spine	extending slightly beyond anus but not to first anal-fin spine base	not reaching to base of first anal-fin spine	not reaching to base of first anal-fin spine	not reaching to base of first anal-fin spine
Condition of chin pores	10 pores, anterior pores usually hidden by cluster of papillae; often slit-like pores posteriorly	10 obvious pores; often slit-like pores posteriorly	10 obvious pores; often slit-like pores posteriorly	10 obvious pores; often slit-like pores posteriorly	10 obvious pores; often slit-like pores posteriorly	10 pores, including 2 very small pores near symphysis plus 4 pores on each lower jaw (sometimes slit-like posteriorly); posterior pores rarely covered by membrane	10 pores, including 2 very small pores (perfectly hidden by cluster of barbels) near symphysis plus 4 pores on each lower jaw (sometimes slit-like, a pit partially or perfectly covered posteriorly by membrane)
Dense black margin on soft dorsal, caudal and anal fins posteriorly	present	absent	absent	absent	absent except caudal fin	absent	absent
Stripe and band patterns on head and body	5–7 alternating whitish and dark brown bands on head body	4 narrow longitudinal dark stripes in specimens < ca.100 mm SL, and then 2nd and 3rd stripes remain but their width becoming narrow (less than pupil diameter)	2 faint narrow longitudinal stripes	5 broad longitudinal dark stripes even in specimens > 200 mm SL, and width of 4th stripe nearly equal to pupil diameter	2 indistinct oblique bands	2 indistinct oblique bands	2 indistinct oblique bands on body in young or stressed specimens but usually indistinct in larger adults

*Lim (1994) reported a single specimen of H. analis from Singapore (as questionably), but a total of 3 specimens of the species have been collected in the vicinity of Singapore (K. K. P. Lim, ZRC, pers. comm.).

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Two new species of *Parapercis* (Perciformes: Pinguipedidae) from north-eastern Australia, and rediscovery of *Parapercis colemani* Randall & Francis, 1993

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Abstract

Johnson, J.W. 2006. Two new species of *Parapercis* (Perciformes: Pinguipedidae) from north-eastern Australia, and rediscovery of *Parapercis colemani* Randall & Francis, 1993. *Memoirs of Museum Victoria* 63(1): 47–56.

Two new species of pinguipedid fishes, *Parapercis flavolabiata* and *P. sexlorata*, are described. The former is known from 20 specimens collected by epibenthic sled and demersal trawl from within the Great Barrier Reef, Australia, between Anzac Reefs and Lady Musgrave Island, in depths from 45 to 79 m. It is most similar to *Parapercis multiplicata* Randall, 1984 and *P. colemani* Randall & Francis, 1993 in appearance, but is unique among the genus in having a combination of dorsal rays V, 21, anal rays I, 17–18, lateral-line scales 51–55, palatines edentate, angle of subopercle produced and with small spinules, 9–10 abdominal and 20 caudal vertebrae, and colouration including six broad red saddles across the back, a purplish-red line from the anterior edge of each orbit around the snout, and a series of yellow-edged red spots on the postorbital part of the head and nape. *Parapercis sexlorata* is described from seven specimens trawled off central eastern Australia between Cape Moreton, Queensland and North Solitary Island, New South Wales in 86 to 137 m. It is easily distinguished from its closest congeners with palatine teeth and dark transverse bars, *P. macrophthalma* Pietschmann, 1911 and *P. muronis* Tanaka, 1918, by having four rather than five dorsal-fin spines and six rather than five transverse bars. *Parapercis colemani* Randall & Francis, 1993 was previously known only from the holotype, collected in 1.5 m depth in the lagoon of Norfolk Island. Additional specimens collected on the NORFANZ survey in the Tasman Sea indicate that the species usually inhabits much deeper habitats and occurs over a wider geographic area. New localities and meristic data are reported for the additional material.

Keywords Pinguipedidae, *Parapercis*, new species, Queensland, Great Barrier Reef, Australia

Introduction

Parapercis Bleeker, 1863 currently includes about 54 recognised species, including 51 from the Indo-west Pacific and single representatives in the south-eastern Pacific, south-eastern Atlantic and north-eastern Atlantic (Cantwell, 1964; Randall and McCosker, 2002; Randall, 2003; Randall and Yamakawa, 2006; this study). While shallow reef-dwelling species are relatively well known, those found on soft-bottom habitats in depths in excess of 50 m have been more poorly sampled and elucidated. A study of pinguipedid fishes in Australian ichthyological collections has revealed a number of undescribed species taken during demersal trawl surveys. Two of these species are described herein.

Parapercis colemani Randall & Francis, 1993 was described from a single female collected in a shallow sandy bay at Norfolk I. The authors indicated that they were unable to locate further specimens in the region despite expending considerable effort, and surmised that the species may have been a waif from a breeding population elsewhere, possibly in relatively deep water. In 2003 a consortium of Australian, New Zealand and French scientific organisations collaborated to investigate the biodiversity of benthic communities on the Norfolk Ridge and Lord Howe Rise of the Tasman Sea on the NORFANZ cruise. Specimens of an unidentified species of *Parapercis* collected at two widely separated localities during this cruise are here identified as *P. colemani*, confirming these assumptions. New localities, meristic data, and other details at variance with the original description are reported for the material.

Methods and materials

Institutional acronyms for types and comparative material are those of Leviton et al., 1985. Lengths of specimens are given as standard length (SL), being the distance from the front of the upper lip to the base of the caudal fin (posterior end of the hypural plate). The abbreviation HL is used for head length. Lateral-line scale counts are to the base of the caudal fin, and do not include several additional pored scales on the fin. Gill-raker counts include all rudiments. Vertebral counts were made from radiographs. Where assessed, sex was determined by examination of gonads through a small incision in the abdomen.

Measurements were taken with dial calipers, to the nearest 0.5 mm for SL and the nearest 0.1 mm for all other measurements, with the aid of a stereo microscope where necessary. Methods for counts and measurements otherwise follow Randall, 2003. Where different, values for paratypes follow those of the holotype in parentheses. Specimens of *P. flavolabiata* were collected by epibenthic sled and *P. sexlorata* by trawl, except where indicated otherwise. Meristic and morphometric details for the new species are presented in Tables 1–2.

Comparative material examined

Parapercis macrophthalma ZMB 16160, holotype, 107.5 mm, Takao, Taiwan, Dr. Haberer.

Parapercis muronis BSKU 36390, 126 mm, Tosa Bay, Japan, 6 Feb 1982; BSKU 37293, 122 mm, Tosa Bay, Japan, 27 Apr 1982.

Parapercis flavolabiata sp. nov.

Yellowlip Grubfish

Figures 1–2, 5; Tables 1–2.

Material examined. Holotype. QM I. 37762, male, 84 mm, east of Mystery Cay, Qld, 21°22.5'S, 152°07.5'E, 55 m, C. Bartlett on FRV *Lady Basten*, 19 Nov 2005.

Paratypes: (N = 16) AMS I.43796-001, 3: 39-85 mm, NW of Reef 21-253, Qld, 21°20.1'S, 152°15.9'E, 60 m, C. Bartlett on FRV *Lady Basten*, 20 Nov 2005; CSIRO H.6303-01, 79 mm, SE of Anzac Reefs, Qld, 18°47.1'S, 147°57.3'E, trawl 79.2 m, D. Gledhill on FRV *Gwendoline May*, 13 Dec 2003; QM I. 36139, 3: 55-83 mm, west of Riptide Cay, Qld, 21°14.1'S 151°45'E, 45 m, C. Bartlett on FRV *Lady Basten*, 25 May 2005; QM I. 36598, 43 mm, NE of Eulalie Reef, Qld, 19°06.3'S, 148°06.9'E, 55 m, C. Bartlett on FRV *Lady Basten*, 9 Sept 2004; QM I. 36632, 91 mm, west of Stucco Reef, Qld, 19°33.3'S, 149°31'E, 77 m, C. Bartlett on FRV *Lady Basten*, 11 Sept 2004; QM I.37763, 2: 49 mm, east of North Reef, Qld, 23°11.1'S, 152°00.9'E, 65 m, C. Bartlett on FRV *Lady Basten*, 9 Nov 2005; QM I.37764, 3: 35–53 mm, north of Joist Reef, Qld, 19°26.1'S, 149°40.5'E, 74 m, C. Bartlett on FRV *Lady Basten*, 26 Nov 2005; QM I.37765, 48 mm, NE of Hyde Reef, Qld, 19°42.3'S, 150°10.5'E, 70 m, C. Bartlett on FRV *Lady Basten*, 26 Nov 2005; QM I.37766, 67 mm, SE of Lady Musgrave I., Qld, 23°54.9'S, 152°30.9'E, 52 m, C. Bartlett on FRV *Lady Basten*, 5 Nov 2005.

Other material: BPBM 40411, 59 mm, north of Hyde Reef, Qld, 19°39.9'S, 150°04.5'E, 77 m, C. Bartlett on FRV *Lady Basten*, 26/11/2005; CSIRO H.6329-01, 83 mm, WSW of Mystery Cay, Qld, 21°24.9'S, 151°52.5'E, trawl 67 m, D. Gledhill on FRV *Gwendoline May*, 27/11/2005; QM I.37767, 82 mm, NE of Lavers Cay, Qld, 21°11.1'S, 152°07.5'E, trawl 61 m, D. Gledhill on FRV *Gwendoline May*, 3 Dec 2005.

Diagnosis. Dorsal-fin rays V, 21; anal-fin rays I, 17–18 (usually I, 17); pectoral-fin rays 16–18 (usually 17); lateral-line scales 51–55; gill rakers 3–5+10–11; predorsal scales 8–9; scales on cheek cycloid, in about 11 horizontal rows; usually 8 canine teeth in outer row at front of lower jaw; vomer with a crescentic row of 6–10 robust conical teeth; palatines edentate; angle of subopercle produced, with about 7 small spinules; 9–10 abdominal and 20 caudal vertebrae; colouration including 6 broad red saddles across the back, a purplish red to violet line from the anterior edge of each orbit around the snout, a series of yellow-edged red spots on the postorbital part of the head and nape, and a row of dark-red spots along soft dorsal fin.

Description. Dorsal-fin rays V, 21; anal-fin rays I, 17 (I, 17–18, only 2 with I, 18); all dorsal- and anal-fin rays branched, last to base; pectoral-fin rays 17 (16–18, 2 with 16, 1 with 18), upper ray unbranched, others including lowermost branched; pelvic-fin rays I, 5; branched caudal-fin rays 14 (14–15); lateral-line scales 53 (51–55), plus 2–3 smaller scales on caudal-fin base; scales above lateral line to origin of dorsal fin 5 (5–6), to base of anterior soft rays of dorsal fin 3½; scales below lateral line in an oblique row to origin of anal fin 11 (11-12); circumpeduncular scales 24; predorsal scales 9 (8–9), extending just anterior to a vertical from preopercular margin; horizontal row of scales from preorbital across cheek to edge of preopercle 19; gill rakers on 1st arch 3+11, total 14 (3–5+10–11=13–16); branchiostegal rays 6; vertebrae 9+20 (one paratype with 9 +20, 2 with 10+20).

Body depth 6.15 (5.7–6.3) in SL; body subcylindrical, greatest width 0.95 (0.90–0.95) in body depth; head length 3.35 (3.1–3.4) in SL; snout pointed, its length 3.6 (3.55–4.0) in HL; orbit diameter 3.45 (3.35–3.7) in HL; eyes directed more laterally than dorsally, bony interorbital space narrow, 8.05 (8.0–11.2) in HL; caudal-peduncle depth 3.3 (3.15–3.6) in HL; caudal-peduncle length 2.95 (2.85–3.5) in HL.

Mouth slightly oblique, lower jaw protruding slightly, with curved canine teeth at front of each jaw slightly projecting and visible when mouth is closed; upper jaw extending to a vertical at anterior margin of pupil, upper jaw length 2.5 (2.3–2.65) in HL; upper jaw with 22 (20–23) outer curved canines, first 8 or 9 clearly the largest, of these 8th or 9th the largest, those following gradually reducing in size posteriorly, broad inner band of villiform teeth anteriorly, narrowing gradually to form only 2 rows at rear of jaw; front of lower jaw on each side with 4 (3–4) enlarged curved canines in distinctly separate outer row (6 paratypes with total of 8, 3 with 7, and 7 with 6), tooth nearest symphysis smallest, the others gradually increasing in size laterally, last in the series largest, broad inner band of villiform teeth extending posteriorly from symphysis to side of jaw just posterior to largest tooth in outer row, next 6 (5–9) teeth in single row, enlarged and gradually increasing in size posteriorly, then followed by single row of 14 (13–15) smaller slightly curved conical teeth. Vomer with crescentic row of 9 (6–10) robust conical teeth, medial teeth largest, usually several smaller additional teeth posteriorly; palatines edentate. Tongue spatulate with broadly rounded tip.

Gill membranes united with broad free fold, not attached to isthmus. Gill rakers short, the longest about one-third length of longest gill filament on first gill arch. Anterior nostril small, inconspicuous, situated in front of centre of eye, slightly more than half distance to tip of snout, with membranous posterior flap, the latter folded around near base to form partial tube, flap usually lying flat against snout in preserved specimens. Posterior nostril slightly more than half distance from snout to anterior margin of eye, dorsoposterior to, and about twice width of anterior nostril, its opening simple, aperture slightly oval-shaped; internarial distance about 1.5 times width of posterior nostril.

Opercle with distinctly exposed, robust, pointed spine, angle of subopercle expanded and armed with about 7 small spinules; preopercle and remainder of subopercle entire, the margins naked and broadly rounded.

Figure 1. Holotype of *Parapercis flavolabiata*, QM I.37762, 84 mm SL, male.

Lateral line continuous, ascending smoothly from opercle to below 2nd or 3rd soft dorsal-fin ray, then approximately following contour of back; scales ctenoid, except for those on nape, cheeks, breast, midline of belly, and some anteriorly on opercle and posteriorly on base of pectoral fins, those on middle of sides with about 36 cteni; scales on cheek extending forward approximately to a line between middle of eye and posterior tip of maxilla; no scales on dorsal, anal or pelvic fins; 2 or 3 rows of small cycloid scales on base of pectoral-fin rays; elongate ctenoid scales densely arranged on proximal two-thirds of caudal fin.

Origin of dorsal fin at or just posterior to a vertical from tip of opercular flap, the predorsal length 3.25 (3.1–3.35) in SL; 1st dorsal-fin spine shortest, 11.35 (9.05–12.85) in HL; 2nd and 3rd dorsal-fin spines progressively longer; 4th dorsal-fin spine longest, 3.8 (3.3–4.25) in HL; 5th dorsal-fin spine intermediate in height between 2nd and 3rd spines; membrane from 5th spine to 1st soft ray moderately notched, attached at about two-thirds height of 5th dorsal-fin spine; longest dorsal-fin soft ray the 19th (19th–20th), 1.95 (1.95–2.25) in HL; origin of anal fin below base of 5th to 6th soft dorsal-fin ray, preanal length 2.1 (1.95–2.1) in SL; anal-fin spine slender, closely attached to 1st soft ray, 5.7 (4.95–7.45) in HL; longest soft anal-fin ray the 15th (15th or 16th), 2.35 (2.15–2.5) in HL; caudal fin emarginate, in males 2nd and 3rd branched ray from upper margin produced to form a short filament, and about 10th–13th rays slightly produced to form a small rounded lobe, length of caudal fin without filament 4.75 (3.85–4.7) in SL; pectoral fins rounded, 10th ray usually longest, 4.7 (4.55–5.05) in SL, shorter than pelvic fins; origin of pelvic fins in advance of upper base of pectoral fins and approximately on a vertical from upper corner of operculum, prepelvic length 3.8 (3.5–3.85) in SL; pelvic-fin spine closely attached to 1st soft ray, its termination fleshy and difficult to accurately determine; 4th soft pelvic-fin ray longest, reaching to base of 2nd soft anal-fin ray (origin of anal fin to base of 3rd soft ray), 4.1 (3.7–4.25) in SL.

Colour in alcohol. Head, body and fins mostly uniformly pale yellowish-brown. Some faint dark saddles dorsally above lateral line persisting in larger specimens.

Colour fresh. Male holotype pale pinkish-white above on body, with 6 broad inverted triangular red saddles, extending almost to ventral midline on each side. Secondary narrow vertical red bars between the 3rd and 4th, 4th and 5th and 5th and 6th saddles, and on the caudal peduncle extending ventrally from lateral line to a similar level. A small red blotch also in the same series, just below pectoral fin base. Pigmentation of bars and saddles darker blood-red at their lower apex. Lower sides, belly and breast shading to pearly white. Head mostly flesh-pink. Opercle below opercular spine and adjacent upper four-fifths of pectoral-fin base pale yellow. A short diffuse oblique red and yellow bar (red anteriorly, yellow posteriorly) from tip of maxilla to about half distance to middle of eye. A distinct purplish-red to violet line broadly but faintly margined in pale orange-yellow from middle of anterior edge of orbit, curving around snout to meet orbit on opposite side. Chin and anterior half of upper and lower lips diffusely flushed with red. Posterior half of upper lip bright yellow. Purple-pink reflective band across anterior part of interorbital, followed posteriorly by a small pale-yellow blotch adjacent to inner edge of each eye. Transverse row of 3 yellow-edged red spots across occipital region, lowermost on each side behind upper third of eye, the upper central spot on dorsal midline. Four additional yellow-edged red spots in a crescentic row on nape immediately behind head, upper 2 directly behind inner margin of orbit, lowermost on anterodorsal edge of post-temporal. Area from upper corner of operculum to posterodorsal part of head diffusely washed in yellow. Posteroventral margin of orbit with faint purple-pink reflective line underlying the orbital membrane. Dorsal and ventral margins of iris yellow, followed by a broad purplish-red area extending to upper and lower edges of pupil respectively, remainder of iris behind and in front of the pupil yellow. Distal third of spinous dorsal fin membrane pale translucent yellow.

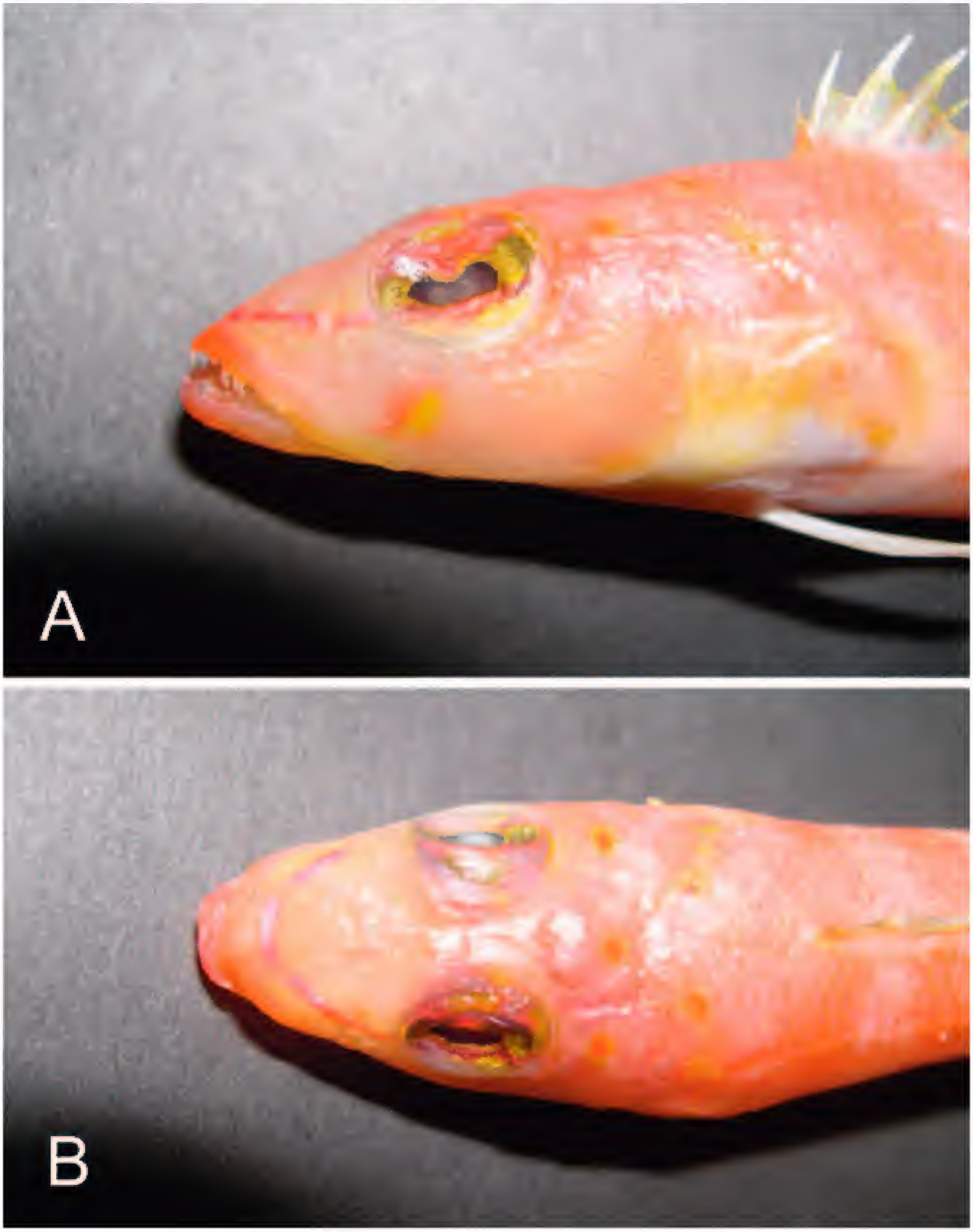

Figure 2. Holotype of *Parapercis flavolabiata*, QM I.37762, 84 mm SL, male. (A) Lateral view of head (B) Dorsal view of head.

Table 1. Selected meristic and morphological values for type specimens of *Parapercis flavolabiata* and *P. sexlorata* (measurements as percentage of standard length).

	P. flavolabiata		*P. sexlorata*	
	Holotype QM I.37762	Paratypes (n = 16)	Holotype QM I.33274	Paratypes (n = 6)
Standard length (mm)	84.0	35.0–91.0	120.0	73.5 – 95.0
Dorsal-fin rays	V, 21	V, 21	IV, 23	IV, 23
Anal-fin rays	I, 17	I, 17 – I, 18	19	19
Pectoral-fin rays	17	16–18	19	19
Gill rakers	3 + 11	3–5 + 10–11	6 + 9	4–6 + 8–10
Lateral-line scales	53	51–55	56	53–57
Lower jaw teeth (outer row)	4 + 4	3–4 + 3–4	3 + 3	3 + 3
Vertebrae (abdominal + caudal)	9 + 20	9–10 + 20	10 + 22	9 + 23 (2)
Body depth	16.3	15.9–17.5	19.3	15.6–18.1
Body width	17.4	17.4–18.5	18.3	18.0–19.8
Head length	29.8	29.2–32.5	26.8	25.6–27.9
Snout length	8.2	7.8–8.5	5.7	5.8–6.3
Orbit diameter	8.6	8.4–9.6	7.9	8.4–9.5
Interorbital width	3.7	2.7–3.8	2.3	1.6–2.2
Preorbital depth	4.3	3.7–4.7	3.9	3.1–3.8
Upper jaw length	12.0	11.9–13.6	12.1	11.2–12.8
Predorsal length	30.8	29.7–32.2	30.8	29.0–31.2
Preanal length	47.9	47.6–51.6	45.2	46.0–48.7
Prepelvic length	26.3	26.1–28.4	24.7	24.1–26.0
Caudal-peduncle depth	9.0	9.0–9.5	10.0	9.3–10.1
Caudal-peduncle length	10.1	9.1–10.2	7.8	7.6–8.9
Dorsal-fin base	62.0	59.1–62.5	67.3	61.5–65.3
First dorsal-fin spine length	2.6	2.4–3.3	4.1	2.6–4.4
Second dorsal-fin spine length	5.4	3.9–4.9	5.2	3.7–5.7
Third dorsal-fin spine length	7.1	6.4–7.7	5.7	5.1–6.0
Fourth dorsal-fin spine length	7.9	7.6–9.2	5.9	5.7–7.1
Fifth dorsal-fin spine length	5.7	5.2–7.5	-	-
Longest dorsal-fin ray	15.4	14.0–15.7	15.0	13.5–15.3
Anal-fin base	42.3	40.7–43.0	45.6	43.9–46.8
Anal-fin spine length	5.2	4.3–5.8	3.8	4.6–5.4
Longest anal-fin ray	12.7	12.5–13.6	12.9	13.1–13.4
Caudal-fin length	21.1	21.4–25.9	17.2	19.1–21.5
Pectoral-fin length	21.3	19.8–21.9	20.6	20.1–22.3
Pelvic-fin length	24.5	23.4–26.9	20.4	22.0–23.7

Table 2. Frequency of lateral-line scales and gill rakers in type specimens of *Parapercis flavolabiata* and *P. sexlorata* and in type and non-type material of *P. colemani* (* denotes holotype).

	Lateral-line scales							
	51	52	53	54	55	56	57	58
P. flavolabiata	1	5	5*	5	1	-	-	-
P. colemani	-	-	-	-	1	2	1	1*
P. sexlorata	-	-	1	1	2	2*	1	-

	Gill rakers												
	Upper				Lower				Total				
	3	4	5	6	8	9	10	11	12	13	14	15	16
P. flavolabiata	3*	12	2	-	-	-	9	8*	-	2	8*	5	2
P. colemani	3*	1	1	-	-	1	2	2*	-	2	2*	1	-
P. sexlorata	-	1	-	6*	1	4*	2	-	1	-	-	4*	2

Basal two-thirds of membrane between 1st and 2nd dorsal spines blood-red, that between other spines mainly transparent, but with numerous tiny white dots. Soft dorsal fin with numerous tiny white dots, translucent yellow on basal and distal 3rd, but with central 3rd transparent. Distinctive small dark-red spot in transparent area just above midheight of fin following each ray. Anal fin with basal half translucent whitish and distal half pale translucent yellow. Caudal fin with a broad oblique blood-red band covering about one-third of fin anterodorsally, but extending to full length of fin ventrally, followed by a central white area, and a broad pale-yellow margin distally. Narrow bright-yellow edge to anterodorsal half of caudal fin. Centre of fin with about 4 small darker red smudge-like spots interspersed with dusky melanophores. Pectoral fins transparent. Pelvic fins white, with a faint yellowish blush proximally. Tongue pinkish-white. Peritoneum white.

Distribution. Demersal trawl grounds between Anzac Reefs, 18°47.1'S, 147°57.3'E and Lady Musgrave I., 23°54.9'S, 152°30.9'E, Great Barrier Reef, Qld, in depths from 45 to 79.2 m. (fig. 4).

Etymology. From the latin *flavo* for yellow and *labiata* for lipped, in reference to the distinctive yellow posterior half of the upper lip.

Remarks. *Parapercis flavolabiata* is most similar in colouration to *P. multiplicata* Randall, 1984, sharing with that species a series of reddish saddles across the back and a row of dark-red spots along the soft dorsal fin, however it may easily be distinguished by the presence of only six saddles (rather than eight), dark marking in spinous dorsal fin confined to first membrane (rather than anterior three), presence of a bright-yellow upper lip, purplish-red line across the snout, and series of yellow-edged red spots on the postorbital region of the head (all absent), fewer pectoral fin rays (16–18, usually 17 versus 14–16, usually 15), lower lateral-line scale count (51–55 versus 56–58) and fewer predorsal scales (8–9 versus 10–12). *Parapercis colemani* Randall & Francis, 1993 has similar colouration and meristics to *P. flavolabiata*, but has five reddish saddles that only cover the upper third of the body and a series of ten separate vertical yellow bars below (versus six red saddles continuous to lower sides and interspersed posteriorly with independent shorter red bars), lacks the distinctive head markings of *P. flavolabiata*, and has a higher lateral-line scale count (55–58 versus 51–55). *Parapercis punctulata* Cuvier, 1829 and *P. signata* Randall, 1984 are also somewhat similar in colouration, but have dark markings and spots on anal fin (absent in *P. flavolabiata*), differ markedly in the colouration of the head and spinous dorsal fin (membranes of the latter with black blotch covering entire base), and have more lateral-line scales (55–57 versus 51–55).

This species was taken during a wide-ranging study of benthic inter-reef fishes and invertebrates across the entire Australian Great Barrier Reef region. Most prior surveys of this region have been more restricted geographically and have concentrated on areas fished commercially for penaeid prawns and scallops, *Amusium* spp, using variously adapted commercial otter trawl gear and scallop dredges. This survey utilised small but fairly conventional trawl gear, but employed a specialised epibenthic sled with a diameter of 1.5 m and stretched mesh size of 25 mm. Almost 1200 tows of 200 m were undertaken with this apparatus. It was responsible for the capture of numerous poorly known benthic fish species and accounted for all but three of the specimens collected of *Parapercis flavolabiata*.

Parapercis sexlorata sp. nov.

Sixstrap Grubfish

Figures 3–5; Tables 1–2.

Material examined. Holotype. QM I. 33274, 120 mm, east of Cape Moreton, Qld, 27°03.58'S, 153°31.57'E, 86 m, Qld Fisheries Service, 14 Mar 2001.

Paratypes: (N = 6) AMS I.22873-004, 91 mm, SE of Cape Byron, NSW, 28°43'S, 153°49'E to 28°39'S, 153°50'E, 128–137 m, K. Graham on FRV *Kapala*, 1 Nov 1978; AMS I.31484-006, 86 mm, off Brunswick Heads, NSW, 28°27'S, 153°50'E, 119–137 m, K. Graham on FRV *Kapala*, 16 Feb 1991; AMS I.37977-002, 2: 73.5–93 mm, off Sandon Bluffs, NSW, 29°40'S, 153°40.6'E, 107–109 m, K. Graham on FRV *Trader Horn*, 8 Jul 1999; AMS I.40445-004, 95 mm, off Sandon Bluffs, NSW, 29°39'S, 153°41'E to 29°42'S, 153°40'E, 108–117 m, K. Graham on FRV *Trader Horn*, 5 Jul 1999; QM I. 37579, 84.5 mm, ENE of North Solitary I., NSW, 29°54'S, 153°36'E, 102 m, K. Graham on FRV *Kapala*, 2 Aug 1978.

Diagnosis. Dorsal-fin rays IV, 23; anal-fin rays I, 19; pectoral-fin rays 19; lateral-line scales 53-57; gill rakers 4–6+8–10; predorsal scales 10–11; scales on cheek ctenoid, in about 9 horizontal rows below middle of eye; 6 canine teeth in outer row at front of lower jaw; vomer with a crescentic outer row of 6–7 robust conical teeth and several smaller teeth behind; palatines with a single row of about 7 robust conical teeth; angle of subopercle produced, with several feeble spinules; 9–10 abdominal and 22–23 caudal vertebrae; head and body pink, with 6 narrow oblique posteroventrally-directed black bars across the back, 1st extending to lateral line, 2nd to middle of sides, others to lower 3rd of body; a small black spot in upper corner of caudal-fin base; scales above lateral line in area between bars and spot with dusky margins; spinous dorsal fin membrane dusky; upper lip yellowish.

Description. Dorsal-fin rays IV, 23; anal-fin rays I, 19; all dorsal- and anal-fin rays branched, last to base; pectoral-fin rays 19, upper ray unbranched, others including lowermost branched; pelvic-fin rays I, 5; branched caudal-fin rays 15; lateral-line scales 56 (53–57), plus 2–3 smaller scales on caudal-fin base; scales above lateral line to origin of dorsal fin 4½ (4½–5½), to base of anterior soft rays of dorsal fin 3½ (3½–4½); scales below lateral line in a oblique row to origin of anal fin 14 (13–14); circumpeduncular scales 24; predorsal scales 11 (10–11), extending forward just posterior to a vertical from preopercular margin; horizontal row of scales from preorbital across cheek to edge of preopercle about 19; gill rakers on 1st arch 6+9, total 15 (4–6+8–10=12–16); branchiostegal rays 6; vertebrae 10+22 (2 paratypes with 9+23).

Body depth 5.15 (5.5–6.4) in SL, more robust in larger specimens; body subcylindrical, greatest width 1.05 (0.80–1.0) in body depth, depth equal to or greater than width only in larger specimens; head length 3.75 (3.6–3.9) in SL; snout bluntly rounded, its length 4.7 (4.1–4.65) in HL; orbit diameter

Figure 3. Holotype of *Parapercis sexlorata*, QM I.33274, 120 mm SL, male.

Figure 4. Paratype of *Parapercis sexlorata*, QM I.37579, 84.5 mm SL (Photo: K. Graham).

3.4 (2.75–3.1) in HL; eyes directed as much dorsally as laterally, bony interorbital space narrow, 11.9 (11.65–15.7) in HL; caudal-peduncle depth 2.7 (2.6–3.0) in HL; caudal-peduncle length 3.4 (3.0–3.65) in HL.

Mouth slightly oblique, jaws terminal, curved canine teeth at front of each jaw slightly projecting, but concealed by lips when mouth is closed; upper jaw extending to a vertical at posterior margin of pupil, upper jaw length 2.2 (2.05–2.5) in HL; upper jaw with 19–21 outer curved canines, first 10 (8–10) larger than those following, of these either 1st or 9th usually the largest, 11th and subsequent teeth gradually reducing in size posteriorly, broad inner band of villiform teeth anteriorly, narrowing gradually but still forming several rows at rear of jaw; front of lower jaw on each side with 3 enlarged curved canines in distinctly separate outer row, tooth nearest symphysis smallest, 3rd in the series largest; broad inner band of villiform teeth extending posteriorly from symphysis to side of jaw 4–5 rows posterior to largest tooth in outer row, next 2 teeth abruptly larger, then followed by single row of 15–16 smaller slightly curved conical teeth. Vomer with

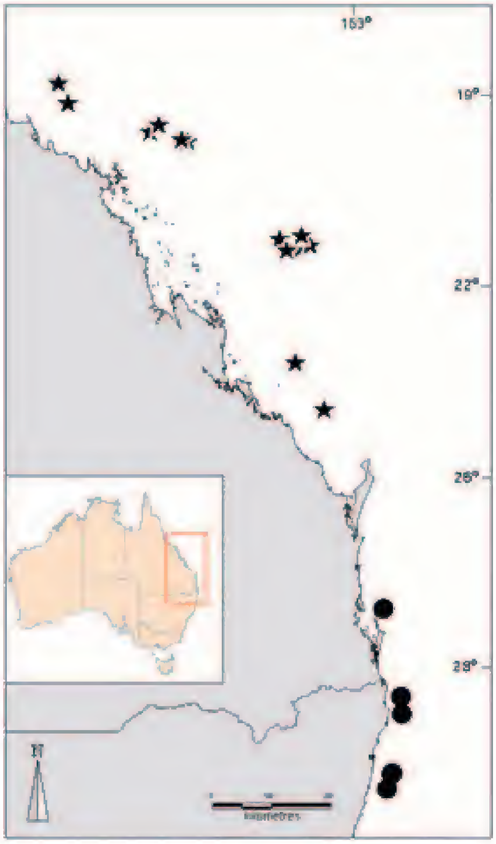

Figure 5. Distribution of *Parapercis flavolabiata* and *P. sexlorata* based on specimens examined.

crescentic outer row of about 7 robust conical teeth, medial teeth largest, several smaller adjacent teeth posteriorly; palatines with row of about 7 robust conical teeth and several closely spaced additional teeth near midsection of row. Tongue spatulate with broadly rounded tip, covered with numerous minute papillae.

Gill membranes united with broad free fold, not attached to isthmus. Gill rakers short, the longest about one-sixth length of longest gill filament on 1st gill arch. Anterior nostril moderately large, situated in front of centre of eye, about half distance to tip of snout, with membranous posterior flap, the latter folded around near base to form partial tube. Posterior nostril about half distance from anterior nostril to anterior margin of eye, dorso-posterior to, and slightly wider than anterior nostril, its opening simple and slightly raised, aperture slightly oval-shaped; internarial distance about twice width of posterior nostril.

Opercle with distinctly exposed, robust, pointed spine, angle of subopercle expanded, with several feeble spinules; preopercle and remainder of subopercle entire, the margins naked and broadly rounded.

Lateral line continuous, ascending from opercle to below 2nd or 3rd dorsal spine, then approximately following contour of back; scales ctenoid, except for some on shoulder region and pectoral-fin rays and those on nape, breast and midline of belly, scales on middle of sides with about 40–50 cteni; scales on cheek extending forward approximately to a line between middle of eye and midlength of maxilla; no scales on dorsal, anal or pelvic fins; small elongate scales on pectoral-fin rays, some rows covering proximal half of fin; elongate ctenoid scales densely arranged on proximal three-fourths of caudal fin.

Origin of dorsal fin distinctly posterior to a vertical from tip of opercular flap, the predorsal length 3.25 (3.2–3.45) in SL; 1st dorsal-fin spine shortest, 6.55 (6.0–10.5) in HL; subsequent spines progressively longer; 4th (3rd or 4th) dorsal-fin spine the strongest, 4th always the longest, 4.5 (3.75–4.55) in HL; membrane from 4th spine to 1st soft ray moderately notched, attached at about two-thirds height of 4th dorsal-fin spine; longest dorsal-fin soft ray the 17th (17th–20th), 1.8 (1.75–1.9) in HL; origin of anal fin below base of 4th or 5th soft dorsal-fin ray, preanal length 2.2 (2.05–2.2) in SL; anal-fin spine slender, closely attached to 1st soft ray, 7.15 (4.95–5.65) in HL; longest soft anal-fin ray the 16th (16th or 17th), 2.05 (1.9–2.05) in HL; caudal fin rounded, length of caudal fin 5.85 (4.65–5.25) in SL; pectoral fins rounded to very bluntly pointed, 10th ray usually longest, 4.85 (4.5–5.0) in SL, slightly longer than pelvic fins (shorter than pelvic fins in all smaller paratypes); origin of pelvic fins slightly in advance of upper base of pectoral fins and on a vertical just anterior to tip of operculum, prepelvic length 4.05 (3.85–4.15) in SL; pelvic-fin spine closely attached to 1st soft ray, its termination fleshy and difficult to accurately determine; 4th soft pelvic-fin ray longest, reaching midway between vent and anal fin origin (from midway between vent and anal-fin origin to base of 1st anal-fin soft ray), 4.9 (4.2–4.55) in SL.

Colour in alcohol. Holotype, QM I.33274 (fig. 3) pale yellowish brown, with 6 narrow mostly oblique posteroventrally-directed black bars across the back and upper sides, 1st extending from immediately anterior to origin of spinous dorsal fin to lateral line, 2nd from 2nd soft dorsal-fin ray to middle of sides, others from 7th, 12th, 17th, and 22nd soft dorsal-fin rays to lower 3rd of body. Small black spot in upper corner of caudal-fin base. Scales above lateral line in area between each transverse bar and between last bar and caudal spot with dusky margins, producing a reticulate pattern. A narrow pale border around each transverse bar. Lower sides, belly, breast and snout to preopercle pale yellowish-brown. Upper part of opercle and upper postorbital region to rear of interorbital dark-brown, punctuated above margin of preopercle with a central pale area. A narrow curved brown line extending ventrally behind eye from postorbital area to just below lower margin of eye. Midline of nape with a broad band of scales with dusky margins, extending posteriorly from origin of scaled area to 1st transverse black bar anterior to dorsal-fin origin. Spinous dorsal-fin membrane diffusely dusky. Transverse black bars of upper body produced slightly on to base of adjacent soft dorsal-fin rays and membrane, soft dorsal fin otherwise uniformly pale. Middle section of inner pelvic-fin rays dusky to black. Anal fin uniformly pale. Caudal fin with 7 contrasting narrow dark wavy vertical lines.

Figure 6. *Parapercis colemani*, NMV A.25112-003, 84 mm SL (Photo: NORFANZ Founding parties).

Colour fresh. Based on colour photograph of paratype, QM I.37579 (fig. 4), pale-pink on head and body, with 6 transverse black bars and a black spot on upper corner of caudal-fin base. Each bar produced ventrally in dusky-yellow. Belly and breast shading ventrally to pinkish-white. Scales above lateral line in area between each transverse bar and between last bar and caudal spot with distinct dusky margins, producing a reticulate pattern. A narrow pink border, devoid of dusky-edged scales, around each transverse bar. Much of pectoral-fin base, postorbital and opercle diffusely dusky, infused with yellow. Upper lip dark orange-yellow, lower lip white. Spinous dorsal fin dusky grey. Soft dorsal-fin rays orange anteriorly, some wavy oblique orange lines visible posteriorly, membrane mostly translucent. Inner pelvic-fin rays dusky at midsection, whitish at base, yellowish distally. Anal fin faintly orange. Caudal fin mauve with about 7 narrow wavy vertical orange-yellow lines.

Distribution. Scattered on demersal trawl grounds between Cape Moreton, Qld, 27°03.58'S, 153°31.57'E and ENE of North Solitary I., NSW, 29°54'S, 153°36'E, in depths from 86 to 137 m (fig. 5).

Etymology. From the latin *sex* for 6 and *lorata* for strap, in reference to the 6 distinctive narrow black strap-like bars across the back of this species.

Remarks. Among currently recognised species, *Parapercis sexlorata* is most similar to *P. macrophthalma* Pietschmann, 1911 and *P. muronis* Tanaka, 1918, sharing with those taxa palatine teeth and a series of black bars across the back and upper sides. However it may easily be distinguished by the dorsal-fin ray count of IV, 23 versus V, 23–24, six versus eight canine teeth in outer row of lower jaw, and six versus five transverse bars. This species appears to be quite rare, with only seven specimens captured in a region that has been surveyed quite intensively by demersal trawl on various occasions since the late 1970s.

New records of *Parapercis colemani* Randall & Francis, 1993

Parapercis colemani Randall & Francis, 1993 was described from a single female collected in 1.5 m depth in a sandy inshore lagoon at Norfolk I. There have been no published records or additional material reported since the original description. Three specimens of an unidentified species of *Parapercis* were collected in 2003 during the NORFANZ cruise, one from the Lord Howe Rise and two from the Northern Norfolk Ridge, Tasman Sea region, in depths of 89–113 m. These are identified here as conspecific with *P. colemani*. The new records indicate that the species usually inhabits much deeper habitats over a considerably wider geographic area than was previously inferred from the type locality. It is difficult to draw conclusions on the abundance of the species from NORFANZ results, as few trawls were undertaken in the depth range that specimens were caught (over 90% of trawls and sleds were in depths greater than 200 m).

The new material has identical dorsal-, anal- and pectoral-fin ray counts, and similar dental formulae to the holotype. Several other counts and features at slight variance to the original description are reported below. The lateral-line scale and gill raker counts are slightly expanded (Table 2). Pelvic fins of the holotype are described as "not reaching anus" and their length 1.7 in HL. However in the new material they reach to between the base of the first to third soft rays of the anal fin, and are 1.2–1.3 in HL. The holotype is damaged, with the right pelvic fin cut off at the base and missing, and the left one missing the distal portion of the third to fifth rays. From proportional measurements given for the type and a current measurement of the damaged left fin, the pelvic fin appears to have been measured to the tip of the longest intact (second) ray, rather than to the tip of the longer fourth ray. It is therefore difficult to accurately compare the pelvic fin length and reach of the type versus new non-type material. However, in the new material the second pelvic-fin ray reaches between two scales prior to the anus and the midpoint of the anus, whereas in the

type it reaches to about four scales prior to the anus, indicating that the type had slightly shorter pelvic fins overall. The female holotype has the second to fourth caudal-fin rays only slightly prolonged, the fin length to tip of upper lobe 1.4 in HL. Although the new specimens are all larger than the type, those with intact fins have these rays distinctly prolonged, the fin length 1.1–1.2 in HL.

Colouration of the type, based on the original description and figures, and direct comparison of the preserved specimen, is almost identical with the new material (fig. 6), with the following exception. The type has a longitudinal row of eight small vague dark spots on the upper side (dusky orange-red in fresh specimen). Although these still persist in the preserved type specimen, they are lacking in the other material. In all other details, including the formation of the five dark saddles above, ten yellow bars below, faint midlateral white stripe, reddish blotch below eye, series of small transverse dark markings across the top of the head and postorbital, and fin colouration, they are entirely consistent.

Material examined. Parapercis colemani AMS I.33434-001, holotype, female, 82 mm, Norfolk I., Emily Bay, eastern side, 29°04'S, 167°57'E, spear, 1.5 m, J.E. Randall, 17 Feb 1991; CSIRO H.6028-02, female, 107 mm, Tasman Sea, Lord Howe Rise, SE of Lord Howe I., 31°49'S, 159°20'E, benthic sled, 89 m, P. Last, A. Graham and D. Gledhill on RV *Tangaroa*, 22 May 2003; NMNZ P.11712, 87 mm, Norfolk I., R. Bell, 4 Aug 1913; NMV A.25112-003, males?, 2: 83–84 mm, Tasman Sea, North Norfolk Ridge, 28°54.43'S, 167°40.54'E, beam trawl, 111–113 m, D. Bray on RV *Tangaroa*, 15 May 2003.

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Simipercis trispinosa, a new genus and species of sandperch (Perciformes: Pinguipedidae) from eastern Australia

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Abstract

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Simipercis trispinosa is described as a new genus and species of pinguipedid fish from 93 specimens collected mostly by demersal trawl from the continental shelf of eastern Australia between Swain Reefs, Queensland and Broken Bay, New South Wales in depths from 51 to 170 m. The new genus is most closely related to *Parapercis* Bleeker, 1863, but is unique among pinguipedid fishes in having a combination of vomer and palatines edentate, dorsal spines 3, no distinct exposed, pointed opercular spine, preopercle and subopercle entire, ten abdominal and 20–21 caudal vertebrae, low naked fleshy nuchal crest, interorbital and suborbital with large ctenoid scales extending forward to near anterior margin of eye, and head and body moderately compressed.

Keywords Pinguipedidae, *Simipercis*, Parapercis, new genus, new species, Queensland, New South Wales, Australia

Introduction

Rosa and Rosa, 1998 provided a diagnosis and definition of the Pinguipedidae, describing three primary osteological synapomorphies of the family: hyomandibular with oblique crest (Gosline, 1968), intercalar with sharp posteriorly directed process, and sphenotic with elongate, anteriorly directed process. Imamura and Matsuura, 2003 redefined the family using 14 derived characteristics, only one of which was used by Rosa and Rosa (hyomandibular with oblique crest). They also confirmed that *Cheimarrichthys* von Haast, 1874 should be excluded from the Pinguipedidae and placed in its own family, Cheirmarrichthyidae.

The Pinguipedidae currently contains five genera: the monotypic *Kochichthys* Kamohara, 1961 from Japan and Taiwan, *Pinguipes* Cuvier, 1829 with one species from each of the south-eastern Pacific and south-western Atlantic, the monotypic *Prolatilus* Gill, 1865 from the south-eastern Pacific, *Pseudopercis* Miranda-Ribeiro, 1903 with two species from the south-eastern Atlantic, and *Parapercis* Bleeker, 1863 with about 54 recognised species, including 51 from the Indo-west Pacific and single representatives in the south-eastern Pacific, south-eastern Atlantic and north-eastern Atlantic (Rosa and Rosa, 1998; Randall and McCosker, 2002; Imamura and Matsuura, 2003; Randall, 2003; Randall and Yamakawa, 2006; this study).

The first author recently examined all known pinguipedid specimens throughout Australian ichthyological collections to validate identifications for a project on demersal continental shelf and slope fishes. During these studies two nominal species of *Parapercis*, *P. naevosa* Serventy, 1937 and *P. stricticeps* De Vis, 1884, regarded by Cantwell, 1964 as junior synonyms of *P. allporti* (Günther, 1876) and *P. xanthozona* (Bleeker, 1849) respectively, were discovered to be valid species. In addition, a number of undescribed species collected by demersal trawl were also identified. Most of these currently await description, but the most distinctive of the latter is described here.

Methods and materials

Institutional acronyms for types and comparative material are those of Leviton et al, 1985. Lengths of specimens are given as standard length (SL), being the distance from the front of the upper lip to the base of the caudal fin (posterior end of the hypural plate). The abbreviation HL is used for head length. Lateral-line scale counts are to the base of the caudal fin, and do not include several additional pored scales on the fin. Gill-raker counts include all rudiments. Vertebral counts and descriptions of osteological features were made from radiographs and skeletal preparations. Methods for counts and measurements otherwise follow Randall, 2003. Where different, values for paratypes follow those of the holotype in parentheses. Specimens were

collected by trawl, except where indicated otherwise. Meristic and morphometric details for the new species are presented in Tables 1–2. Material examined for detailed comparison of opercular osteology is listed. However an additional 30 unlisted species of *Parapercis* were examined externally for character states of the opercular bones.

Comparative material examined

Parapercis binivirgata QM I.37220, 146 mm, SE of Cape Moreton, 27°03'S, 153°31'E, 86 m, 14 Mar 2001 (skeleton).

Parapercis nebulosa QM I.36874, 113 mm, Hervey Bay, 25°03.5'S, 152°46.6'E, 16.6 m, 1 Jul 2002; QM I.36875, 152 mm, same data (skeletons).

Parapercis sp.3 (undescribed) QM I.36876, 118 mm, east of South Stradbroke I., 27°48.8'S, 153°49.7'E, 161–165 m, 24 Jul 2002 (skeleton).

Simipercis **gen. nov.**

Type species. Simipercis trispinosa sp. nov.

Diagnosis. The type species of *Simipercis* differs from all other genera of the family Pinguipedidae in having 3 dorsal spines, a low naked fleshy nuchal crest (fig. 1d), and dorsal angle of opercular bone broad, not forming a distinct exposed, pointed spine (figs 2a–d), and a combination of the following features: vomer and palatines edentate, subopercle and preopercle entire, 10 abdominal and 20–21 caudal vertebrae, scales including those on head and pelvic region large and ctenoid, interorbital with a single row of large scales, extending to, or just beyond anterior margin of eye, suborbital scales reaching a vertical between anterior margin of pupil and anterior margin of eye, and head and body moderately compressed (body width 1.3–1.55 in depth in adults).

Remarks The new genus is most closely related to *Parapercis* Bleeker, 1863, with similar vertebral counts and dental formulae, but is unique among pinguipedid fishes in having three dorsal spines (*Kochichthys* 2, *Parapercis* 4–6, *Pinguipes* 6–7, *Prolatilus* 4, *Pseudopercis* 4–7), a low naked fleshy nuchal crest (no fleshy crest known in other genera), and dorsoposterior angle of opercular bone not forming an exposed, distinctly pointed spine (figs 2a–d). The dorsoposterior angle of the opercular bone is relatively broad and narrowly truncate posteriorly, with a minute shallow notch. The posteroventral edge of the notch forms a feeble, bluntly triangular point which is hidden by the skin in undamaged specimens. A horizontal ridge on the inner surface of the opercular bone is visible externally under light, and is situated well below the dorsal margin of the opercle. The ridge terminates slightly before the posterior tip of opercular bone. In other genera there is at least one exposed, robust, distinctly pointed opercular spine, and in *Parapercis*, the horizontal ridge on the inner face of the opercular bone is situated very close to (rather than well below) its dorsal margin, and extends to the tip, reinforcing the opercular spine (figs 3a–f).

Simipercis also differs from other pinguipedid genera by the combination of: vomer and palatines edentate (only *Prolatilus* lacks vomerine teeth, only *Prolatilus* and some *Parapercis* lack palatine teeth); margin of subopercle entire (usually at least some small spines or spinules in other genera); 10 abdominal and 20–21 caudal vertebrae (*Parapercis* 9–10+18–22, *Kochichthys* 10+19, *Pinguipes* 15–16+20–21, *Prolatilus* 15–16+20–21, *Pseudopercis* 16–18+20–22); large interorbital scales extending to, or just beyond, anterior margin of eye (only *Kochichthys*, *Prolatilus* and *Parapercis haackei* have interorbital scales); cheek and suborbital with large ctenoid scales, extending to a vertical between anterior margin of pupil and anterior margin of eye (variously squamate or naked, usually with small cycloid scales on cheek, suborbital with small scales extending to below middle of eye or more posteriorly in other genera); and head and body moderately compressed (generally cylindrical or subcylindrical anteriorly in other genera). A detailed examination of osteological and myological features was not carried out on *Simipercis;* however it agrees well with the familial diagnosis and description of Rosa and Rosa, 1998 and with additional features of the family defined by Imamura and Matsuura, 2003 that were examined (eg. unique crest on the hyomandibular present, posterior margin of opercular bone moderately concave, six branchiostegal rays, lowermost ray of pectoral fin branched, 15 branched caudal-fin rays).

Etymology. From the Latin *similis*, meaning similar or like, in reference to the pinguipedid genus *Percis* Bloch and Schneider, 1801 (the latter being preoccupied by the agonid genus *Percis* Scopoli, 1777).

Simipercis trispinosa **sp. nov.**

Threespine Grubfish

Figures 1a–e, 2a–d, 4; Tables 1–2.

Material examined. Holotype. QM I. 32697, 114 mm, east of Noosa, Qld, 26°24'S, 153°39'E, 104 m, Queensland Fisheries Service, 22 Jun 2001.

Paratypes: (N = 92) AMS I.31473-002, 130 mm, off Iluka, NSW, 29°24'S, 153°35'E, 67–77 m, K. Graham on FRV *Kapala*, 6 May 1990; AMS I.32121-004, 120 mm, off Newcastle, NSW, 32°53'S, 152°01'E, 73-79 m, K. Graham on FRV *Kapala*, 7 Jun 1990; AMS I.32209-002, 2: 66.5–116 mm, off Newcastle, NSW, 32°54'S, 151°57'E, 64–70 m, K. Graham on FRV *Kapala*, 23 May 1990; AMS I.32217-001, 5: 105.5–135 mm, off Newcastle, NSW, 32°53'S, 152°02'E, 73–75 m, K. Graham on FRV *Kapala*, 29 Aug 1991; AMS I.33510-004, 97 mm, E of Clarence R., NSW, 29°26'S, 153°34'E, 64–68 m, K. Graham on FRV *Kapala*, 2 Apr 1992; AMS I.37355-011, 6: 39–109 mm, E of Swain Reefs, Qld, 22°23.49'S, 153°04.48'E, 170 m, trap, J. Lowry and K. Dempsey on FV *Seadar Bay*, 8 Sep 1995; AMS I.37572-001, 105 mm, south-east of Evans Head, NSW, 29°13'S, 153°31'E, 51–53 m, K. Graham on FRV *Kapala*, 15 Jun 1995; AMS I.37587-008, 100 mm, E of Swain Reefs, Qld, 22°23.49'S, 153°04.48'E, 138 m, J. Lowry and K. Dempsey on FV *Seadar Bay*, 8 Sep 1995; AMS I.37600-030, 2: 70–118 mm, E of Swain Reefs, Qld, 22°28.34'S, 152°59.45'E, 139 m, trap, J. Lowry and K. Dempsey on FV *Seadar Bay*, 8 Sep 1995; AMS I.38271-001, 2: 58–75 mm, off Newcastle, NSW, 32°54'S, 151°58'E, 67–72 m, K. Graham on FRV *Kapala*, 6 Apr 1995; AMS I.40462-001, 2: 87.5–121 mm, south-E of Sandon Bluffs, NSW, 29°40'S, 153°28'E, 55–59 m, K. Graham on FV *Trader Horn*, 6 Sep 1999; AMS I.43651-002, 76 mm, E of Manly, NSW, 33°36.5'S, 151°29.3'E to 33°40.5'S, 151°26.8'E, 69–80 m, K. Graham on FV Kirrawana, 10 Aug 2005; BMNH 2005.6.2.1, 114 mm, E of Coolum, Qld, 26°30.6'S, 153°35.2'E, 102.3 m, Queensland Fisheries Service, 21 Jun 2001; BPBM 37231, 4: 118–125 mm, off Newcastle, NSW, 32°53.5'E, 151°59.5'E, 64–75 m, K. Graham on FRV *Kapala*, 6 Mar 1991; CAS 222272, 116 mm, off Newcastle, NSW, 32°53.5'E, 151°59.5'E, 67.7–71.3 m, K. Graham, 6 Mar 1991; CSIRO H.6247-01, 112 mm, off southern end of Swain Reefs, Qld, 22°26.1'S, 152°41.1'E,

Table 1. Selected meristic and morphological values for type specimens of *Simipercis trispinosa* (measurements as percentage of standard length).

	Holotype QM I.32697	Paratypes (n = 92) (range)
Standard length (mm)	114	39.5 – 135
Dorsal-fin rays	III, 24	III, 24–25
Anal-fin rays	I, 18	I, 17–19
Pectoral-fin rays	20	19–21
Gill rakers	4 + 11 = 15	3–6 + 9–13 = 12–18
Lateral-line scales	50	46–54
Upper jaw teeth (outer row)	27 + 27	24–29 + 24–29
Lower jaw teeth (outer row)	4 + 4	4–5 + 4–5
Vertebrae (abdominal + caudal)	10 + 21	10 + 20 (2)–21 (10)
Body depth	20.7	19.0 – 24.0
Body width	15.3	14.4 – 17.2
Head length	25.9	24.9 – 27.8
Snout length	5.0	4.0 – 6.3
Orbit diameter	9.2	7.4 – 10.2
Interorbital width	2.7	2.2 – 2.9
Preorbital depth	3.8	2.8 – 4.0
Upper jaw length	10.4	9.8 – 11.1
Predorsal length	25.0	24.3 – 26.2
Preanal length	43.0	41.3 – 46.4
Prepelvic length	24.6	22.8 – 25.4
Caudal-peduncle depth	9.1	8.5 – 9.7
Caudal-peduncle length	10.0	8.2 – 11.1
Dorsal-fin base	64.6	64.3 – 70.0
First dorsal-fin spine length	4.2	3.3 – 4.9
Second dorsal-fin spine length	5.4	5.0 – 6.2
Third dorsal-fin spine length	6.9	6.1 – 8.3
Longest dorsal-fin ray	21.3	17.5 – 23.6
Anal-fin base	48.7	46.0 – 49.8
Anal-fin spine length	7.3	6.0 – 8.8
Longest anal-fin ray	14.4	11.9 – 15.1
Caudal-fin length	21.2	19.2 – 25.4
Pectoral-fin length	23.2	20.8 – 23.9
Pelvic-fin length	22.9	18.4 – 26.2

Table 2. Frequency of lateral-line scales and gill rakers in type specimens of *Simipercis trispinosa*.

Lateral-line scales								
46	47	48	49	50	51	52	53	54
2	6	13	13	13	22	12	11	1

Gill rakers															
Upper				Lower					Total						
3	4	5	6	9	10	11	12	13	12	13	14	15	16	17	18
14	50	28	1	8	42	42	-	1	2	12	30	32	15	1	1

112 m, RV *Gwendoline May*, 23 Apr 2004; NSMT P.70863, 105.5 mm, E of Coolum, Qld, 26°30.6'S, 153°35.2'E, 102.3 m, Queensland Fisheries Service, 21 Jun 2001; QM I.22042, 4: 82–116 mm, E of Swain Reefs, Qld, 22°06'S, 153°02'E, 150 m, Queensland Fisheries Service, 28 Aug 1983; QM I.33181, 96 mm, E of Coolum, Qld, 26°32'S, 153°39'E, 123 m, Queensland Fisheries Service, 8 Aug 2001; QM I.33182, 98.5 mm, E of Noosa, Qld, 26°28'S, 153°39'E, 112.3 m, Queensland Fisheries Service, 8 May 2001; QM I.33183, 25: 59.5–123 mm, E of Coolum, Qld, 26°30.6'S, 153°35.2'E, 102.3 m, Queensland Fisheries Service, 21 Jun 2001; QM I.33333, 3: 80–96.5 mm, E of Point Cartwright, Qld, 26°39'S, 153°35'E, 112 m, Queensland Fisheries Service, 14 Sep 2001; QM I.33994, 4: 64–82 mm, E of Noosa, Qld, 26°20'S, 153°46'E, 110 m, Queensland Fisheries Service, 19 Jul 2002; QM I.33995, 16: 65–118 mm, E of Noosa, Qld, 26°25'S, 153°40'E, 119 m, Queensland Fisheries Service, 19 Jul 2002; QM I.34142, 2: 87.5–115 mm, E of Noosa, Qld, 26°24'S, 153°41'E, 98 m, Queensland Fisheries Service, 17 May 2001; QM I.36879, 2: 113–118 mm, E of Noosa, 26°22.2'S, 153°42.4'E, 115–119 m, Queensland Fisheries Service, 19 Jul 2002; USNM 383404 128 mm, off Newcastle, NSW, 32°53.5'E, 151°59.5'E, 67.7–71.3 m, K. Graham, 6 Mar. 1991.

Other material: (spirit specimens) AMS E.2963, 78 mm, 21 km north-east of North Reef, Qld, 23°07'S, 152°05'E, 128 m, FIS *Endeavour*, 1909; AMS I.32199-003, 56 mm, off Angourie, NSW, 29°28'S, 153°33'E, 64-66 m, K. Graham on FRV *Kapala*, 20 Nov 1990; AMS I.33577-001, 107 mm, off Clarence R., NSW, 29°29'S, 153°33'E, 66-70 m, K. Graham on FRV *Kapala*, 19 Mar 1992; AMS I.37978-003, 59 mm, off Sandon Bluffs, NSW, 29°44'S, 153°26'E, 55–61 m, K. Graham on FV *Trader Horn*, 7 Jul 1999; AMS I.39897-003, 112 mm, off Sandon Bluffs, NSW, 29°44'S, 153°26'E, 55–62 m, K. Graham on FV *Trader Horn*, 8 Jul 1999; QM I.36878, 6: 63–118 mm, E of Peregian Beach, 26°25.9'S, 153°45.2'E, 132–134 m, Queensland Fisheries Service, 18 Jul 2002; QM I.37224, 12: 74–121 mm, E of Coolum, Qld, 26°30.6'S, 153°35.2'E, 102 m, Queensland Fisheries Service, 21 Jun 2001. (skeletal specimens) QM I.36870, 79 mm, QM I.36871, 124 mm, QM I.36872, 113 mm, QM I.36873, 100 mm, all E of Coolum, Qld, 26°32.9'S, 153°36.3'E, 119–120 m, Queensland Fisheries Service, 20 Jul 2002; QM I.37223, 109 mm, E of Coolum, Qld, 26°30.6'S, 153°35.2'E, 102 m, Queensland Fisheries Service, 21 Jun 2001.

Diagnosis. See generic diagnosis.

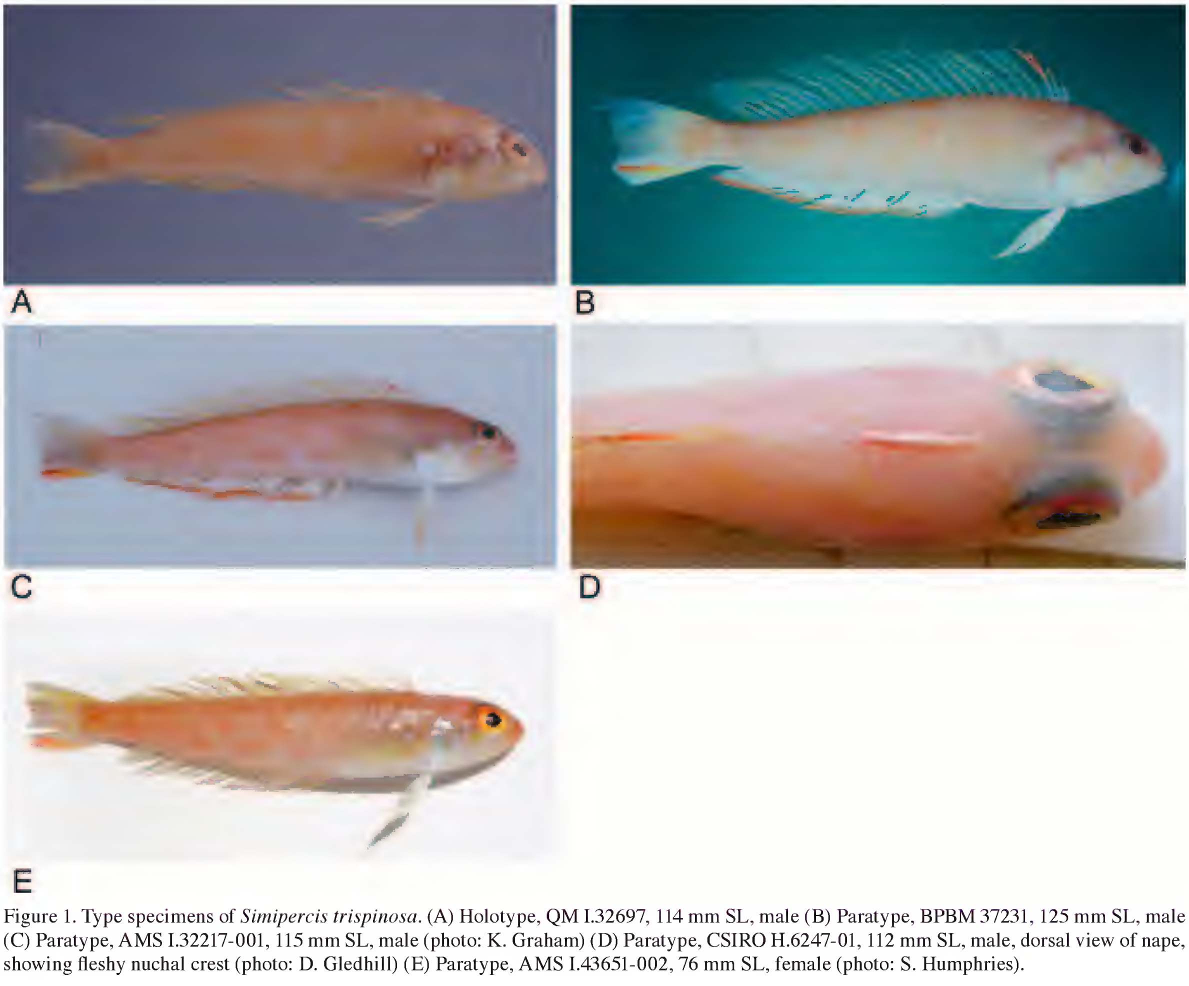

Figure 1. Type specimens of *Simipercis trispinosa*. (A) Holotype, QM I.32697, 114 mm SL, male (B) Paratype, BPBM 37231, 125 mm SL, male (C) Paratype, AMS I.32217-001, 115 mm SL, male (photo: K. Graham) (D) Paratype, CSIRO H.6247-01, 112 mm SL, male, dorsal view of nape, showing fleshy nuchal crest (photo: D. Gledhill) (E) Paratype, AMS I.43651-002, 76 mm SL, female (photo: S. Humphries).

Description. Dorsal-fin rays III, 24 (3 with III, 25 rays); anal-fin rays I, 18 (3 with I, 17 and 1 with I, 19); all dorsal- and anal-fin rays branched, last to base; pectoral-fin rays 20 (19–21, 30 with 19, 5 with 21), upper ray unbranched, others including lowermost branched; pelvic-fin rays I, 5; branched caudal-fin rays 15; lateral-line scales 50 (46–54), plus 3–4 smaller scales on caudal-fin base; scales above lateral line to origin of dorsal fin 3, to base of anterior soft rays of dorsal fin 2½; scales below lateral line in an oblique row to origin of anal fin 10 (10–11); circumpeduncular scales 19 (19–20); predorsal scales about 9 (8–10) to posterior margin of eye, separated along dorsal midline by a low fleshy nuchal crest and not in well-defined rows of equally-sized scales, continuing in a single row of a further 8 (8–9) large scales from posterior margin of eye through interorbital space to anterior margin of eye, or just forward of this point; origin of nuchal crest about 3 scales behind posterior margin of eye, termination about 2½ scales anterior to dorsal-fin origin; horizontal row of scales from preorbital across cheek to edge of preopercle 14; gill rakers on 1st arch 4+11, total 15 (3–6+9–13=12–18); branchiostegal rays 6; vertebrae 10+21 (20–21).

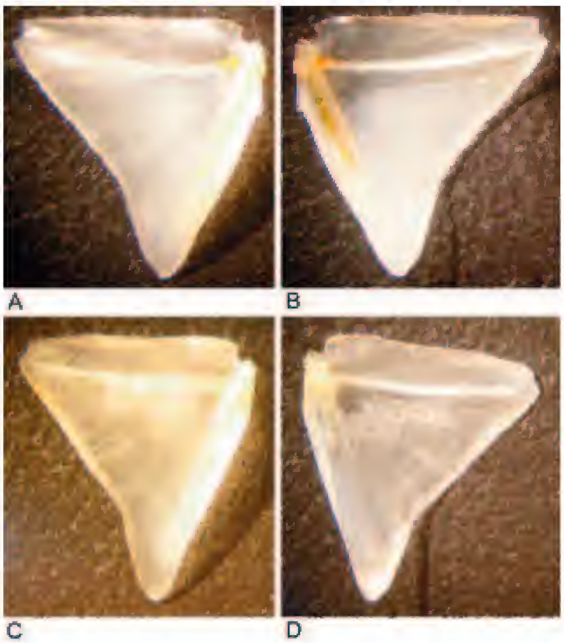

Figure 2. Opercula of *Simipercis trispinosa*, showing poorly developed points at dorsoposterior angle, and low position of inner horizontally-aligned opercular ridge. (A) QM I.36872, 113 mm SL, outer surface (B) QM I.36872, 113 mm SL, inner surface (C) QM I.36871, 124 mm SL, outer surface (D) QM I.36871, 124 mm SL, inner surface.

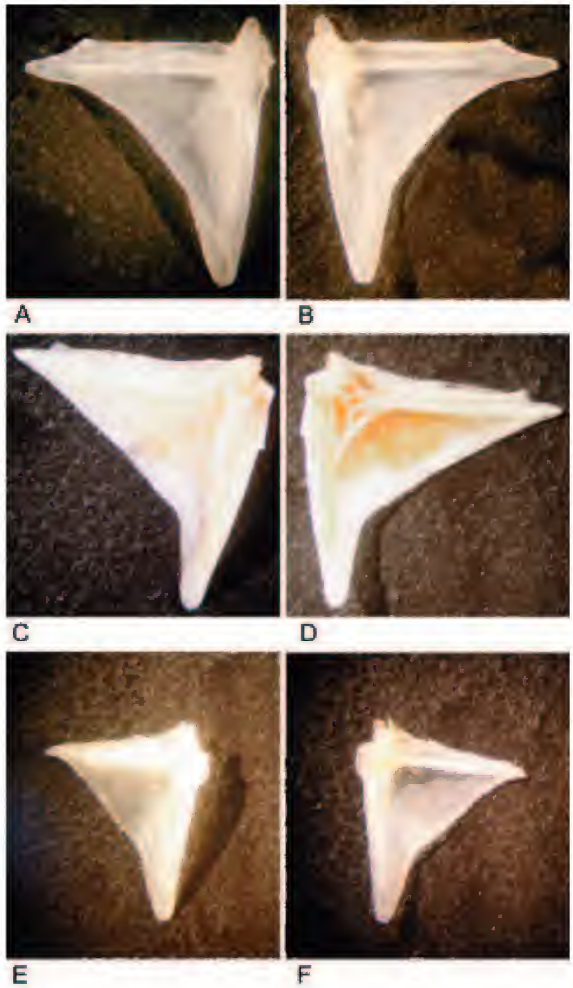

Figure 3. Opercula of selected species of *Parapercis*, showing strong, well-developed spine at dorsal angle and high position of inner horizontally-aligned opercular ridge. (A) *P. binivirgata*, QM I.37221, 146 mm SL, outer surface (B) *P. binivirgata*, QM I.37221, 146 mm SL, inner surface (C) *P. nebulosa*, QM I.36875, 152 mm SL, outer surface (D) *P. nebulosa*, QM I.36875, 152 mm SL, outer surface (E) *P.* "sp. 3", QM I. 36876, 118 mm SL, outer surface (F) *P.* "sp. 3", QM I. 36876, 118 mm SL, inner surface.

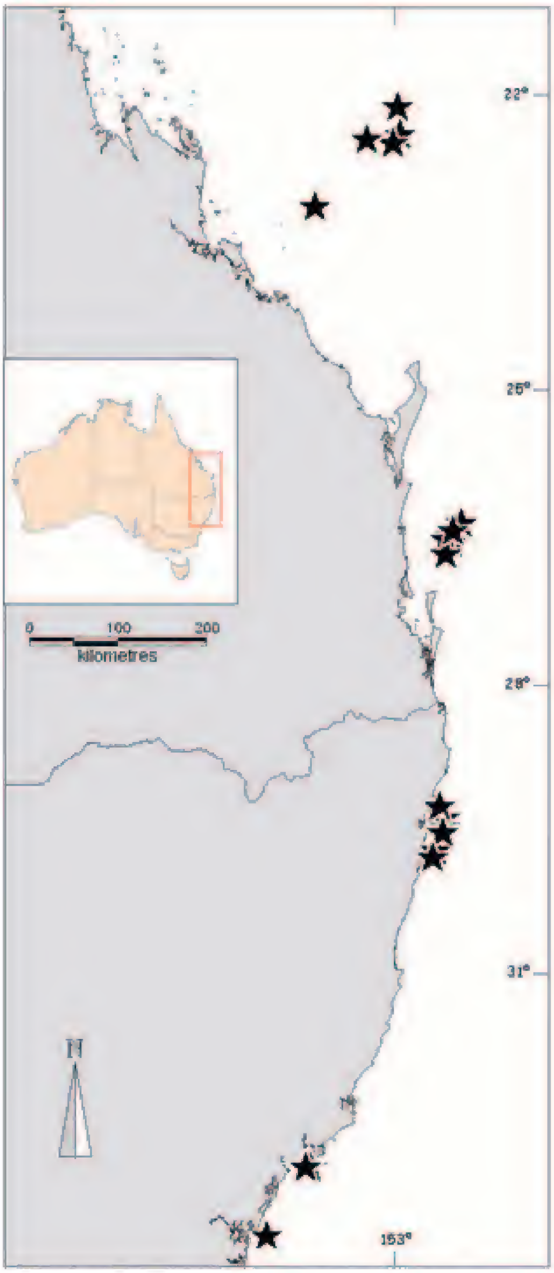

Figure 4. Distribution of *Simipercis trispinosa* based on specimens examined.

Body depth 4.85 (4.15–5.25) in SL; body moderately compressed, greatest width 1.35 (1.15–1.55) in body depth, juveniles subcylindrical, but specimens becoming increasingly compressed with age (1.3–1.55 in specimens greater than 90 mm SL); head length 3.85 (3.6–4.0) in SL, proportionately longest in adults; snout blunt, its length 5.2 (3.9–6.4) in HL; orbit diameter 2.8 (2.6–3.5) in HL; eyes directed more laterally than dorsally, bony interorbital space narrow, 9.5 (8.6–12.0) in HL; caudal-peduncle depth 2.85 (2.65–3.15) in HL; caudal-peduncle length 2.6 (2.35–3.2) in HL.

Mouth slightly oblique, terminal, with curved canine teeth at front of lower jaw slightly projecting and visible when mouth is closed; upper jaw extending to a vertical between anterior margin and middle of pupil, upper jaw length 2.5 (2.35–2.6) in HL; upper jaw with 27 (24–29) outer curved canines, closely and evenly spaced, 2nd or 3rd from symphysis largest, but not distinctly larger than those following, gradually reducing in size posteriorly, broad inner band of villiform teeth anteriorly, narrowing gradually to form single row at rear of jaw; front of lower jaw on each side with 4 (4–5, usually 5) enlarged curved canines in distinctly separate outer row, tooth nearest symphysis smallest, the others gradually increasing in size laterally, 4th usually largest (occasionally 5th), broad inner band of villiform teeth extending posteriorly from symphysis to side of jaw 12–18 rows back, next 5–7 teeth enlarged and in single row (of these, 4–5 posterior-most teeth largest and strongly recurved), then followed by single row of 12–17 smaller slightly curved conical teeth. Total number of teeth in each jaw generally slightly more in adults than in juveniles. Vomer and palatines edentate. Tongue spatulate with broadly rounded tip, its surface covered with tiny papillae.

Gill membranes united with broad free fold, not attached to isthmus. Gill rakers short, the longest about one-third length of longest gill filament on 1st gill arch. Anterior nostril small, inconspicuous, situated in front of centre of eye about one-third distance to tip of snout, with membranous posterior flap, the latter folded around near base to form partial tube, flap usually lying flat against snout in preserved specimens. Posterior nostril close to anterior margin of eye, dorsoposterior to, and about 3 times width of anterior nostril, its opening simple, anterior edge thin and slightly expanded, making aperture slightly oval-shaped; internarial distance about twice width of posterior nostril.

Opercle with no exposed pointed spine; dorsoposterior angle of opercular bone narrowly truncate with minute shallow notch, posteroventral corner of notch broadly and bluntly triangular, but hidden by skin and scales or barely exposed; subopercle and preopercle entire, the margins broadly rounded and slightly overlapped by large ctenoid scales.

Lateral line continuous, ascending fairly abruptly from opercle to below origin of soft dorsal fin, then approximately following contour of back; all scales ctenoid, except for those on pelvic fins and distally on pectoral fins, those on middle of sides with about 50 cteni; scales on cheek extending forward to a vertical between anterior margin of eye and anterior margin of pupil; no scales on dorsal and anal fins; small elongate cycloid scales on basal 3rd of pelvic fins; small scales on basal 4th of pectoral fins, ctenoid proximally and cycloid

distally; proportionately larger ctenoid scales densely arranged on basal two-thirds of caudal fin.

Origin of dorsal fin at a vertical just anterior to tip of opercular flap, the predorsal length 4.0 (3.8–4.1) in SL; 1st dorsal-fin spine shortest, 6.15 (5.1–7.6) in HL; 3rd dorsal-fin spine longest, 3.75 (3.1–4.25) in HL; membrane from 3rd spine to 1st soft ray moderately notched, attached at about four-fifths height of 3rd dorsal-fin spine; longest dorsal-fin soft ray the 19th (18th–20th), 1.2 (1.2–1.45) in HL; origin of anal fin below base of 7th to 8th soft dorsal-fin ray, preanal length 2.35 (2.15–2.4) in SL; anal-fin spine slender, closely attached to 1st soft ray, 3.55 (3.05–3.7) in HL; longest soft anal-fin ray the 15th (15th or 16th), 1.8 (1.7–2.1) in HL; caudal fin truncate to slightly rounded, but in males 3rd branched ray from upper margin filamentous, and about 10th–13th rays slightly produced to form a small lobe, length of caudal fin without filament 4.7 (3.95–5.2) in SL; pectoral fins rounded, 12th ray usually longest, 4.3 (4.2–4.8) in SL, longer than pelvic fins in adults, shorter than pelvic fins in juveniles; origin of pelvic fins in advance of upper base of pectoral fins and slightly anterior to a vertical from dorsal-fin origin, prepelvic length 4.05 (3.95–4.4) in SL; pelvic-fin spine closely attached to 1st soft ray, its termination very fleshy and difficult to accurately determine; 4th soft pelvic-fin ray longest, reaching almost to base of 2nd soft anal-fin ray (origin of anal fin to base of 3rd soft ray), 4.35 (3.8–5.45) in SL.

Colour in alcohol. Head, body and fins mostly uniformly pale yellowish brown. Margins of scales on upper part of body faintly greyish. Narrow naked area of nuchal crest silvery-white (gradually fading in preservative), interspersed variably with dusky melanophores.

Colour fresh. Male holotype pale rose-pink, with numerous vague narrow oblique posteroventrally-directed yellow bands, shading to pearly-white on lower part of opercle, pectoral fin base, breast and belly. Oblique pale yellow bar from lower edge of eye across cheek. Dorsal margin of eye yellow, remainder of iris silvery-white, variably washed with pale red above and posteriorly. Nuchal crest on predorsal midline silvery-white, with numerous scattered dusky melanophores (nuchal crest pale golden-pearl, surrounded basally with diffuse red in paratype CSIRO H. 6247-01, fig. 1d). 1st to 3rd (1st and 2nd in some paratypes) dorsal-fin rays crimson in males, dorsal-fin spines, remaining rays and dorsal-fin membrane pale yellow to semitransparent. Anal-fin membrane chalky-white on basal three-fourths, crimson distally in males. Caudal fin translucent greyish with 4–5 irregular wavy diagonal lemon-yellow bars, lower margin bright-yellow with a crimson flash submarginally on outer half of fin. Some paratypes with yellow and red colouration interspersed along lower margin of fin, and with a lesser 2nd red flash immediately above, near distal edge of fin. Pectoral fins translucent. Proximal half of pelvic fins white, yellowish distally (some larger paratypes with outer half of fin faintly pale red-pink). Peritoneum silvery-black.

Distribution. Demersal trawl grounds between Swain Reefs, Qld (22°06'S, 153°02'E) and Manly, NSW (33°40'S, 151°26'E), at depths of 51–170 m (fig. 4).

Etymology. From the Latin *tres* meaning three, and *spina* meaning thorn or spine, in reference to the 3 dorsal-fin spines, a character state not found in any other species of Pinguipedidae.

Remarks. Although it has a distributional range of at least 11 degrees latitude, *Simipercis trispinosa* has been trawled from only several relatively small areas of the east Australian coast (fig. 4). There appears to be a strong correlation between increased depth of capture and decreasing latitude across the range of the species. Specimens from near the northern range extremity, in the southern Great Barrier Reef region, occur in considerably greater depths (112–170 m) than those at the southern end, in New South Wales (51–80 m). Those centrally located, off the Sunshine Coast in southern Queensland were recorded from intermediate depths (98–123 m). Most trawl catches of *S. trispinosa* have included several males in excess of 110 mm SL with prominent fin markings and well-developed caudal-fin filaments (maximum recorded size 135 mm SL), among a larger group of smaller females, ranging from about 60–100 mm SL. The largest female examined with ripe gonads measured 100 mm SL. Nuchal crests were noted in specimens of all sizes and are not related to age, gender or sexual maturity.

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We thank D. Roy and M. Tonks, Queensland Department of Primary Industries and Fisheries, for provision of fresh specimens; M. McGrouther, Australian Museum, for sending material on loan; D. Gledhill, CSIRO Marine Research, K. Graham, NSW Fisheries and M. McGrouther, for making available photographs of the new species; and H. Imamura, Hokkaido University Museum, for kindly providing vertebral counts of *Kochichthys* and *Pseudopercis* specimens that he had examined.

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Notoraja hirticauda, a new species of skate (Chondrichthyes: Rajoidei) from the south-eastern Indian Ocean

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Abstract

Last P.R. and McEachran J.D. 2006. *Notoraja hirticauda*, a new species of skate (Chondrichthyes: Rajoidei) from the south-eastern Indian Ocean. *Memoirs of Museum Victoria* 63(1): 65–75.

A new skate, *Notoraja hirticauda* sp. nov., is described from off central Western Australia in the south-eastern Indian Ocean. It is distinguished from its congeners in some proportional measurements, the distributions of dermal denticles and bristle-like thorns, the absence of oronasal pits, and several skeletal structures. The new species has a relatively long snout, multiple irregular rows of short thorns on the dorsal and lateral surfaces of the tail, and dermal denticles on the ventral surface of the tail. Its rostral cartilage, which is longer than the nasobasal length, has appendices that are subtriangular in cross-section posteriorly and abut the rostral shaft. Within *Notoraja*, *N. hirticauda* most closely resembles *N. subtilispinosa* Stehmann from the Philippines and Indonesia.

Keywords Chondrichthyes, Rajidae, new species, skate, *Notoraja hirticauda*, south-eastern Indian Ocean

Introduction

The highly diverse and endemic rich skate faunas of Australia and New Zealand are represented by at least 62 species, of which all but two appear to be restricted to the Australasian region (Last and Yearsley, 2002). Similarly, of the 40 or so Australian species (Last and Stevens, 1994), only one also occurs off New Zealand. Several new species have been identified from recent exploratory, trawl-fishing catches in Australian seas but most of these remain undescribed. For example, the rajoid fauna off the western coast of Australia consists of at least 14 species of which only three have been described (Last and Stevens, 1994). Many of these appear to have narrow depth and geographic ranges. Among the least well-known skates, at both specific and supraspecific levels within the suborder, are Australian members of the *Notoraja*-like skates.

McEachran and Miyake (1990) presented a cladogram dividing rajoids into two major clades: Group I consisting of nine supraspecific taxa including the pavorajine subgroups *Pavoraja* Whitley, *Notoraja* Ishiyama and a recently described genus, *Brochiraja* (Last and McEachran, 2006; formerly as an unnamed taxon "Subgenus A" of *Pavoraja*, *sensu* McEachran, 1984); and Group II consisting of 11 supraspecific taxa including "typical" rajine subgroups such as *Raja* and *Dipturus*. Group I skates are well represented in the western Pacific with at least 30 species occurring off Australasia (Last and Yearsley, 2002). However, relationships within the clade, which includes the pavorajine subgroups and *Insentiraja* Yearsley and Last, are not fully understood. McEachran and Last (1994) have suggested that *Brochiraja* (as Subgenus A) is a subgroup of *Notoraja* rather than *Pavoraja*, as originally suggested by McEachran (1984). However, elucidation of the relationships within this generic complex is dependent on descriptions of other members within the clade. *Notoraja* was resurrected by Stehmann (1989) and presently contains four valid nominal species, *N. laxipella* (Yearsley & Last) and *N. ochroderma* McEachran and Last from north-eastern Australia, *N. tobitukai* (Hiyama) from Japan, and *N. subtilispinosa* Stehmann from the Philippines and Indonesia, although other species are known to occur in the Indo-west Pacific (McEachran and Last, 1994). A new species of *Notoraja* is described below based on material from the continental slope off Western Australia.

Several different methods for taking external measurements of skates have been proposed. This has caused considerable confusion in the past, so our methods are explained here in some detail. We used the point-to-point approach proposed by Hubbs and Ishiyama (1968), but raw data are finally expressed as proportions of total length rather than disc width. The preoral length is defined as the measurement from the snout tip to the anterior median edge of the upper jaw rather than to the mouth

proper. Mouth width is the greatest dimension across the tooth band of the upper jaw rather than visible width of the upper jaw between the inner margins of integument (Yearsley and Last, 1992). Spiracular measurements refer to distances around the main depression and do not include the anterior secondary depression. The maximum and minimum widths of the nasal curtain refer to the greatest dimensions across the curtain (usually across the lobes) and the width between the innermost insertions of the curtain immediately before the mouth respectively. The nasal lobe dimension is the greatest width of the lobe from the insertion of the curtain to its lateral margin. Pelvic-fin lobe lengths are taken from the point of articulation of the anterior lobe as described by McEachran and Stehmann (1984) and Stehmann (1985) rather than from the haemal spine (Hubbs and Ishiyama, 1968). The width of the pelvic-fin base is the minimum distance between these points of articulation. Measurements to the cloaca originate from near its posterior margin (i.e. approximated from the origin of the first haemal spine) rather than at its midpoint. Skeletal measurements and counts follow Hubbs and Ishiyama (1968) and McEachran and Compagno (1979, 1982).

Some mature paratypes were dissected to reveal the structure of the neurocranium, scapulocoracoid and clasper; skeletal elements were highlighted with Alcian blue eight GS cartilage stain. All specimens were radiographed to verify anatomical dissections, to count vertebrae, teeth and pectoral-fin radials, and to determine the shape of the pelvic girdle. Specimens examined in this study were obtained from the Australian National Fish Collection, Commonwealth Scientific and Industrial Research Organisation, Hobart (CSIRO).

Notoraja hirticauda sp. nov.

Figures 1–8, Tables 1–3

Notoraja sp. C — Last and Stevens, 1994: 312, figs 33, 34.5, Pl 50 (all fig. captions incorrect, as N. sp B).

Material examined. Holotype. Australia: CSIRO H1816–02, 446 mm TL, mature male, west of Shark Bay, Western Australia, 26°36'S, 112°09'E, 760 m, 28 December 1989, RV "Akebono Maru", sta. 41.

Paratypes (n=8): Australia: CSIRO CA2820, 312 mm TL, female, CSIRO CA2821, 264 mm TL, female, north of Nickol Bay, Western Australia, 18°38'S, 116°54'E, 600 m, 7 Apr 1982, FRV "Soela", Cr. 2, sta. 30; CSIRO CA2822, 241 mm TL, female, CSIRO CA2823, 277 mm TL, female, north of Nickol Bay, Western Australia, 18°41'S, 116°45'E, 596 m, 6 Apr 1982, FRV "Soela", Cr. 2, sta. 28; CSIRO CA2824, 361 mm TL, immature male, north of Nickol Bay, Western Australia, 18°43'S, 116°33'E, 612 m, 7 Apr 1982, FRV "Soela", Cr. 2, sta. 29; CSIRO H1816-03, 448 mm TL, mature male, captured with holotype; CSIRO H1822-01, 372 mm TL, female, west of Shark Bay, Western Australia, 26°44'S, 112°19'E, 735 m, 28 Dec 1989, RV "Akebono Maru", sta. 40; CSIRO H2574-06, 428 mm TL, female, west of Freycinet Estuary, Western Australia, 26°38'S, 112°30'E, 500 m, 30 Jan 1991, FRV "Southern Surveyor", Cr. 1, sta. 37.

Diagnosis. A small species of *Notoraja* with the following combination of characteristics: preoral snout 13.5–15.2% TL; preorbital snout 12.3–13.8% TL; mutiple irregular rows of small, bristle-like thorns and large dermal denticles present on both surfaces of tail; single preorbital thorn present; no oronasal pits; rostral cartilage about 1.25 in nasobasal length; rostral appendices about 62% of nasobasal length, subtriangular in cross-section posteriorly and evenly abutting rostral shaft; pectoral radials 61–66; trunk vertebrae 24–27, precaudal tail vertebrae 71–76; and both surfaces of body pale.

Description. Disc heart-shaped, 1.11 times as broad as long in holotype (1.11–1.16 times in paratypes); maximum angle in front of spiracles 73–75° in adult males, 93–97° in females and juveniles; anterior margin initially straight, slightly more convex in females and immatures, moderately concave opposite spiracles in mature male holotype; posterior margin and corners broadly convex (figs 1, 2). Snout to axis of greatest width 61.5% (57.7–60.9%) of disc length. Snout tip with prominent fleshy and laterally flattened apical process; process rather broad-based and almost continuous with anterior profile of disc in mature males, more lobe-like in immatures and adult females. Pelvic fins deeply incised, anterior lobe moderately long, narrow at base and tapering to blunt point; posterior lobe relatively short, with strongly convex lateral margins; anterior lobe length 95.7% (93–113%) of posterior lobe. Tail narrow at base, tapering gradually posteriorly, very slender toward tip; moderately depressed over length, width 1.42 (1.44–1.72) times height at axil of pelvic fin; slightly convex on ventral surface; lateral skin folds originating well behind posterior pelvic-fin lobes, extending to below mid-length of epichordal caudal-fin lobe and broadening distally (only slightly narrower than height of epichordal lobe); length of tail from rear of cloaca 1.40 (1.40–1.50) times distance from tip of snout to rear of cloaca; predorsal tail length 78.1% (78.2–81.4%) of tail length; width at midlength of tail 2.06 (1.99–2.72) in orbit diameter; width at axils of pelvic fins 0.80 (0.85–1.00) in orbit diameter. Dorsal fins of similar shape and size; rather short and moderately tall with evenly convex anterior margin; posterior margin straight or slightly convex; tip pointed or acutely rounded; fins separated by short interspace. Epichordal caudal-fin lobe relatively well developed, separated by short interspace from and distinctly longer than 2nd dorsal-fin base; hypochordal caudal lobe very low, originating near end of lateral fold, not confluent with epichordal lobe. Preorbital snout length 4.02 (3.15–3.50 in females and immatures) times orbit diameter; preoral snout length 2.29 (1.98–2.35) times internarial distance. Orbit diameter 1.17 (1.11–1.45) times interorbital distance; 1.87 (2.02–3.08) times length of spiracles. Lateral nasal fold expanded slightly, with weak triangular process along lateral margin, posterior margin smooth or with a weak fringe; nasal curtain moderately well developed, broadly rounded and weakly fringed (often hardly detectable) along posterior margin. Oronasal pits absent. Upper and lower jaws slightly arched on either side of symphysis; upper jaw of holotype indented at symphysis, not indented in females and immatures. Teeth in 36 (35–40) series in upper jaw, 34 (32–39) series in lower jaw; plate-like with short cusps in females, cusps acutely pointed in males, arranged quincuncially. Distance between 1st gill slits 1.72 (1.63–1.91) times distance between nostrils; distance between 5th gill slits 1.07 (1.04–1.27) times distance between nostrils; length of 1st gill slit 6.7 (4.7–8.4) times mouth width.

Dorsal surface of disc, posterior lobe of pelvic fin, dorsal fins, epichordal lobe of caudal fin, and lateral skin folds densely

Table 1. Morphometric data for the holotype of *Notoraja hirticauda* sp. nov., with ranges and means for paratypes. Measurements are expressed as percentages of total length

	Holotype CSIRO H1816–02	Paratypes n=8		
		Min	Max	Mean
Total length (mm)	446	241	448	
Disc width	48.7	47.3	51.3	48.7
Disc length	43.7	41.8	45.2	43.0
Head length (dorsal)	17.8	16.9	17.7	17.4
Head length (ventral)	25.1	23.1	25.7	24.3
Snout length (preorbital)	13.8	12.3	13.2	13.0
Snout length (preoral)	15.2	13.5	15.0	14.6
Prenasal length	11.1	10.1	11.0	10.5
Snout to maximum width	26.9	24.5	26.6	25.7
Orbit diameter	3.3	3.8	4.2	3.9
Distance between orbits	2.8	2.7	3.5	3.0
Orbit and spiracle length	4.3	4.2	5.0	4.5
Spiracle length	1.8	1.3	2.1	1.7
Distance between spiracles	5.4	5.4	6.3	5.7
Mouth width	7.2	5.7	6.6	6.3
Nare to mouth	4.3	3.6	4.7	4.2
Distance between nostrils	6.1	6.0	6.4	6.2
Width of first gill slit	1.0	0.8	1.2	1.0
Width of third gill slit	0.8	0.9	1.3	1.1
Width of fifth gill slit	0.7	0.9	1.1	0.9
Distance between first gill slits	10.6	10.4	11.7	11.1
Distance between fifth gill slits	6.5	6.4	7.8	7.2
Length of anterior pelvic-fin lobe	13.7	13.1	15.0	14.4
Length of posterior pelvic-fin lobe	12.2	12.3	14.5	13.4
Tail width at axil of pelvic fins	4.1	4.0	4.5	4.2
Tail height at axil of pelvic fins	2.9	2.5	3.1	2.7
Tail width at tips of pelvic fins	3.9	3.2	3.9	3.6
Tail height at tips of pelvic fins	2.4	2.1	2.6	2.3
Width of tail across its midpoint	1.6	1.5	2.0	1.7
Distance—snout to cloaca	41.7	40.1	42.4	41.0
Distance—cloaca to 1st dorsal fin	45.3	45.6	48.4	46.8
Distance—cloaca to 2nd dorsal fin	50.0	50.2	52.2	50.8
Distance—cloaca to caudal-fin origin	54.5	54.0	56.0	55.0
Distance—cloaca to caudal-fin tip	58.3	58.4	61.0	59.5
Number of tooth rows (upper jaw)	36	35	40	38.2
Number of tooth rows (lower jaw)	34	32	39	35.6
Number of trunk vertebrae	26	24	27	25.4
Number of precaudal tail vertebrae	72	71	76	73.0
Number of pectoral-fin radials	63	61	66	64.2

Table 2. Morphometric data fotr the neurocranium of paratype (CSIRO H1822–01) of *Notoraja hirticauda* sp. nov. Measurements are expressed as percentages of nasobasal length

	Neurocranium	% length
Nasobasal length (mm)	31.4	
Cranial length	72.8	231.8
Rostral cartilage length	39.3	125.2
Rostral cartilage width	1.6	5.2
Prefontanelle length	33.1	105.4
Cranial width	39.0	124.2
Interorbital width	10.1	32.3
Rostral base	3.8	12.0
Anterior fontanelle length	14.4	45.9
Anterior fontanelle width	3.9	12.5
Rostral appendix length	19.3	61.5
Rostral appendix width	5.4	17.2
Rostral cleft length	10.8	34.4
Cranial height	7.4	23.5
Width across otic capsules	19.0	60.5
Width of basal plate	9.0	28.7
Greatest width of nasal aperture	16.4	52.1
Least width of nasal aperture	7.0	22.4
Internasal width	3.9	12.5

Table 3. Morphometric data for the scapulocoracoid of paratype (CSIRO H2574–06) of *Notoraja hirticauda* sp. nov. Measurements are expressed as percentages of scapulocoracoid length

	Scapulocoracoid	% length
Scapulocoracoid length (mm)	22.7	
Scapulocoracoid height	17.2	75.5
Premesocondyle	9.0	39.6
Postmesocondyle	13.7	60.4
Postdorsal fenestra length	6.5	28.8
Postdorsal fenestra height	5.2	23.0
Anterior fenestra length	2.9	13.0
Anterior fenestra combined height	6.5	28.8
Base length	20.6	90.6
Anterior corner height	16.4	71.9
Posterior corner height	12.8	56.1

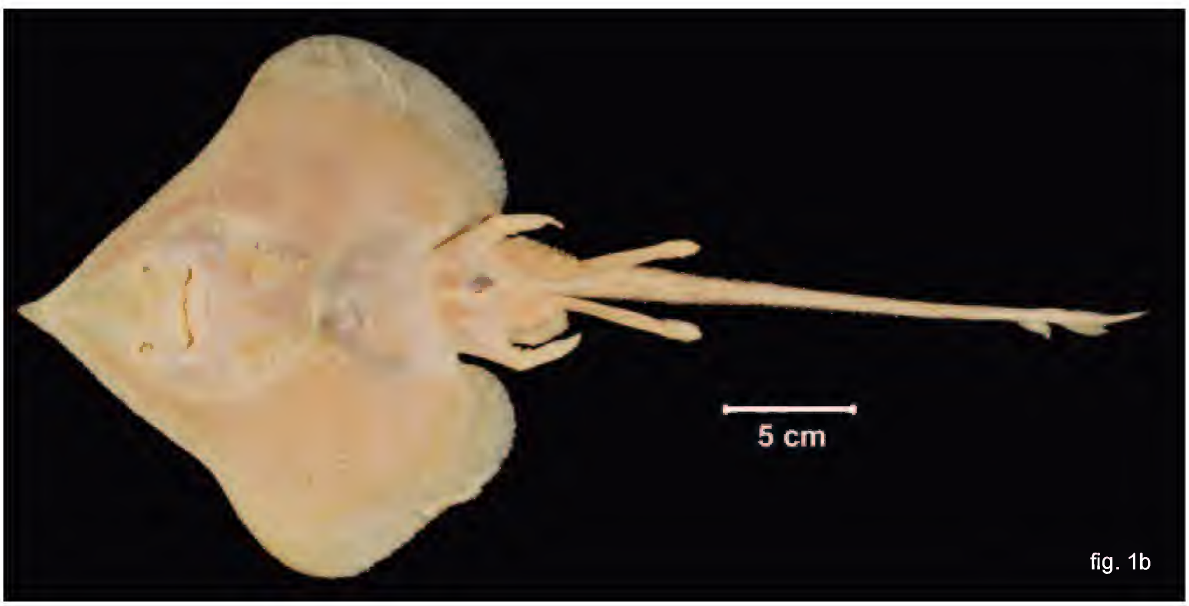

Figure 1. *Notoraja hirticauda* sp. nov. Holotype (CSIRO H1816–02, 446 mm TL, male). a. Dorsal view; b. Ventral view.

Figure 2. *Notoraja hirticauda* sp. nov. Paratype (CSIRO CA2824, 361 mm TL, female). Dorsal view.

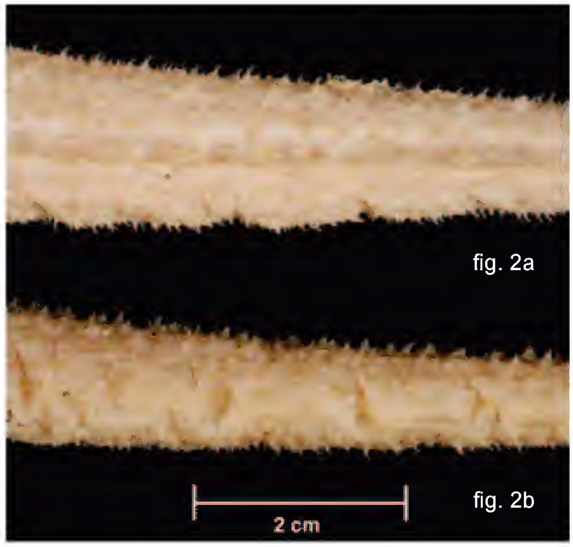

Figure 3. Squamation on the mid-tail of *Notoraja hirticauda* sp. nov. Holotype (CSIRO H1816–02, 446 mm TL, male). a. Dorsal view; b. Lateral view.

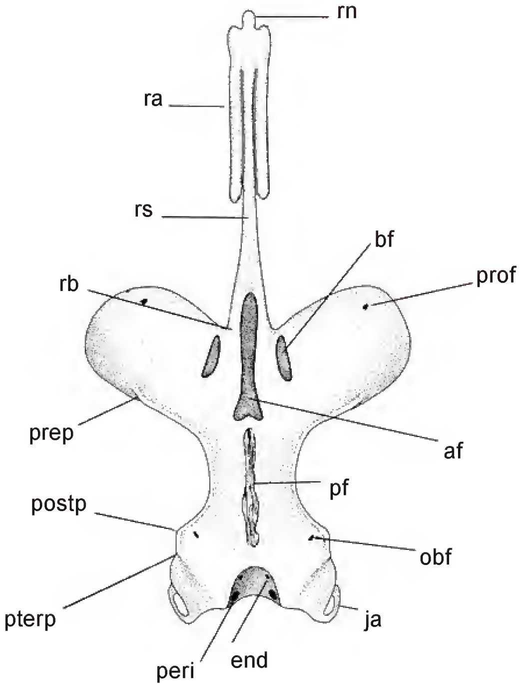

fig. 4a

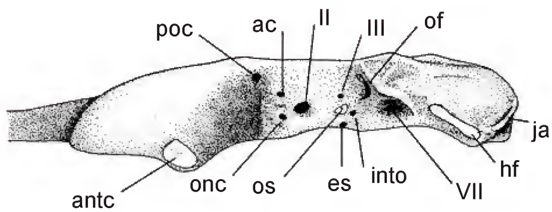

fig. 4b

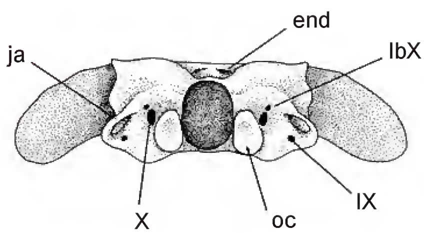

fig. 4c

Figure 4. Neurocranium of *Notoraja hirticauda* sp. nov. Paratype (CSIRO H1822–01, mature female, 372 mm TL: a. dorsal view; b. lateral view; c. posterior view). fig. abbreviations: ac–anterior cerebral vein foramen, af–anterior fontanelle, antc–antorbital condyle, bf–basal fenestra, end–endolymphatic foramen, es–efferent spiracular artery foramen, hf–hyomandibular facet, into–intercerebral vein foramen, ja–jugal arch, lbX–lateralis branch of vagus nerve foramen, obf–otic branch of facial nerve foramen, oc–occipital condyle, of–orbital fissure, onc–orbitonasal canal foramen, os–optic stalk, peri–perilymphatic nerve foramen, pf–posterior fontanelle, poc–preorbital canal, postp–postorbital process, prep–preorbital process, prof–profundus nerve foramen, pterp–pterotic process, ra–rostral appendix, rb–rostral base, rn–rostral node, rs–rostral shaft, II–optic nerve foramen, III–oculomotor nerve foramen, VII–hyomandibular branch of facial nerve foramen, IX–glossopharyngeal nerve foramen, X–vagus nerve foramen.

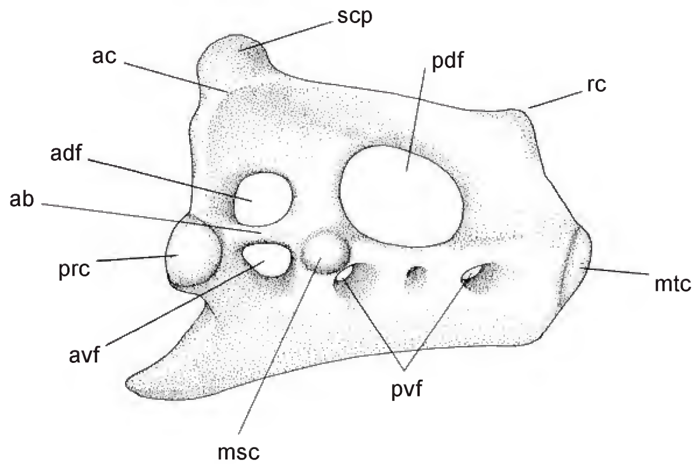

Figure 5. Lateral view of left scapulocoracoid of *Notoraja hirticauda* sp. nov. Paratype (CSIRO H2574–06, mature female, 428 mm TL). fig. abbreviations: ab–anterior bridge, ac–anterior corner, adf–anterodorsal fenestra, avf–anteroventral fenestra, msc–mesocondyle, mtc–metacondyle, pdf–postdorsal fenestra, prc–procondyle, pvf–postventral foramina, rc–rear corner, scp–scapular process.

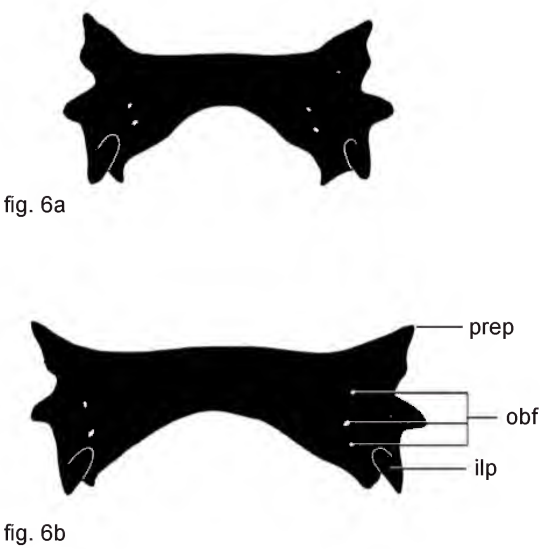

Figure 6. Ventral view of pelvic girdle of *Notoraja hirticauda* sp. nov. a. Holotype, (CSIRO H1816–02, male, 446 mm TL); b. Paratype (CSIRO H2574–06, female, 428 mm TL). fig. abbreviations: ilp–iliac process, obf–obturator foramina, prep–prepelvic process.

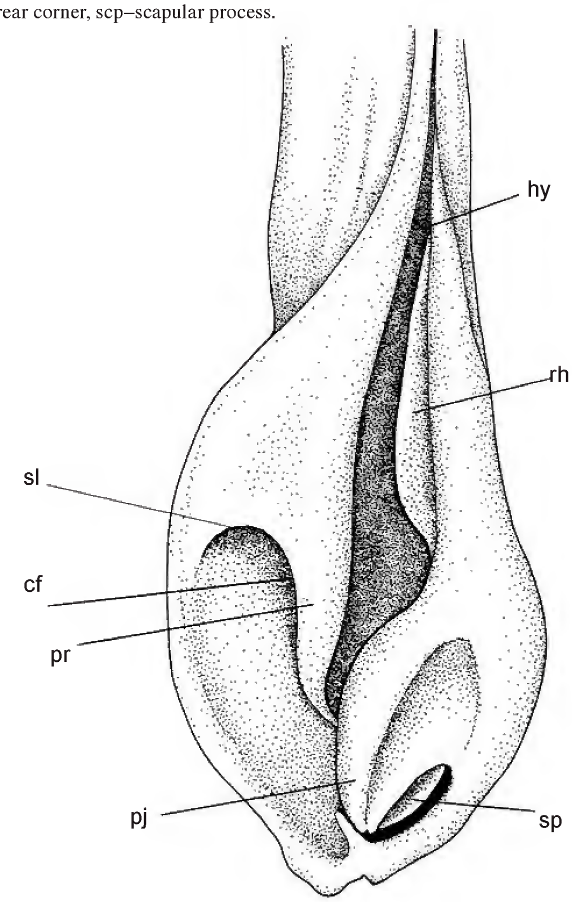

Figure 7. Lateral view, partially expanded, of right clasper of *Notoraja hirticauda* sp. nov. Holotype (CSIRO H1816–02, 446 mm TL, male). fig. abbreviations: cf–cleft, hy–hypopyle, pj–projection, pr–pseudorhipidion, rh–rhipidion, sl–slit, sp–spike.

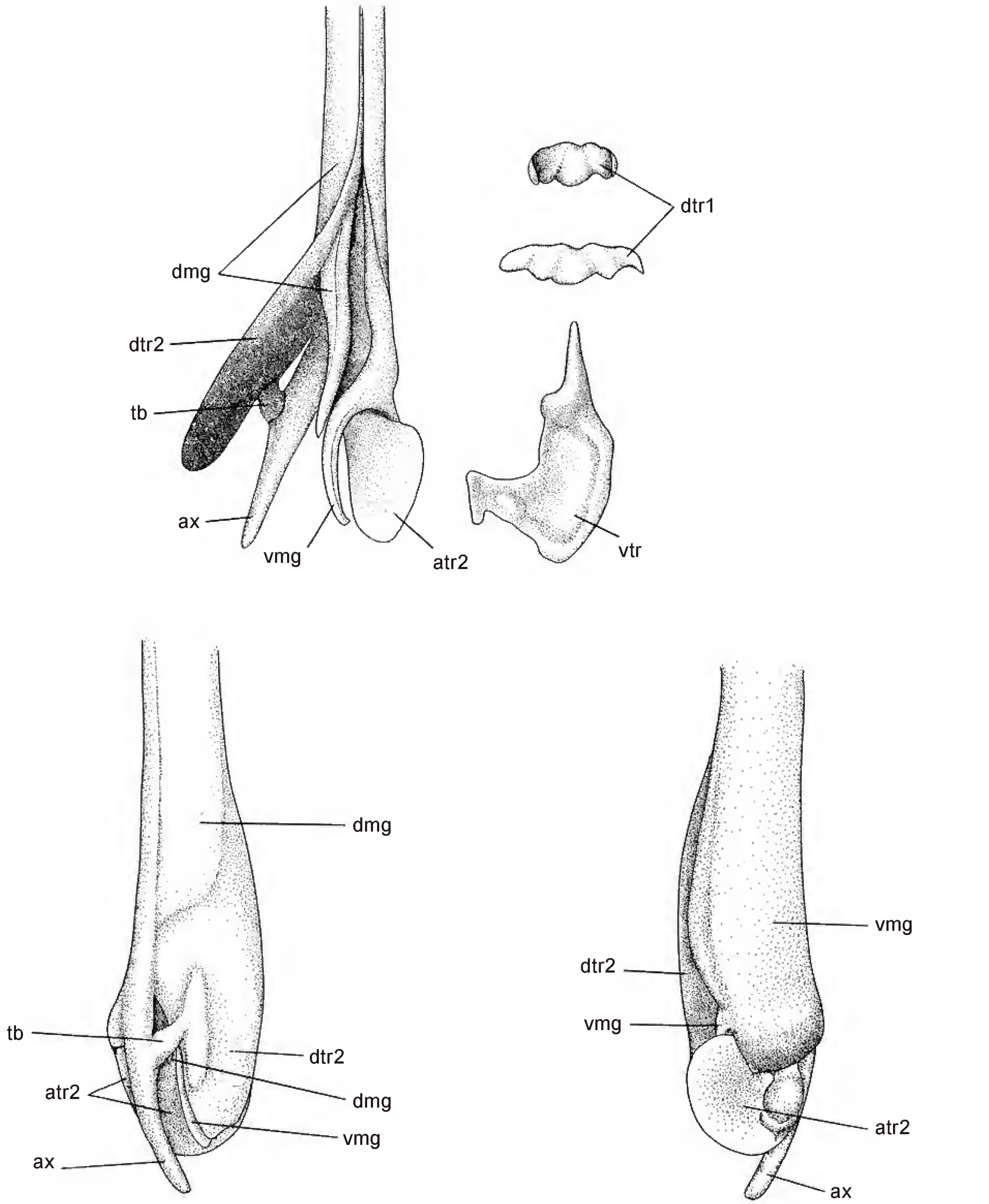

fig. 8a

fig. 8b

fig. 8c

Figure 8. Right clasper cartilages of *Notoraja hirticauda* sp. nov. Holotype (CSIRO H1816–02, 446 mm TL, male): a) lateral view; b) dorsal view; c) ventral view. fig. abbreviations: atr2–accessory terminal 2 cartilage, ax–axial cartilage, dmg–dorsal marginal cartilage, dtr1–dorsal terminal 1 cartilage, dtr2–dorsal terminal 2 cartilage, tb–terminal bridge, vmg–ventral marginal cartilage, vtr–ventral terminal cartilage.

covered with fine, more or less evenly spaced dermal denticles; thorns (fig. 3) small, delicate, confined to tail and preorbit, and alar regions of mature males. Denticle cusps on disc very slender, erect and slightly recurved; bases quadriradial, radii arranged more or less at right angles, anterior radius generally shortest (sometimes barely detectable). Both surfaces of tail densely covered with denticles and small, bristle-like thorns; thorns variable in size, scattered, interspersed with denticles; median thorns in an almost linear series, other thorns distributed randomly or in irregular series; largest thorns long-based, somewhat compressed, sharply pointed distally, upright and triangular or with narrow recurved tips; most numerous dorsally on centre of tail; thorns on ventral surface of tail generally smaller than those dorsally but much larger than denticles of disc. Single, rather short preorbital thorn present. Alar thorns strongly recurved and directed postero-medially, central group in indistinct rows and merging with a cluster of smaller thorns near anterior outer margin of pectoral fin; holotype with about 5–6 central rows, each with 1–4 thorns (mature male paratype with about 9–12 rows, each with 1–2 thorns); all thorns non-depressible, obliquely oriented to surface of disc, not fitting into slits in integument. Claspers, anterior lobes of pelvic fins, and ventral surfaces of disc and posterior pelvic-fin lobes naked; integument of ventral surface rather delicate.

Skeletal morphology. Neurocranium with nasobasal length 20.7% of distance from snout to posterior margin of cloaca and 80.5% of cranial width. Rostral shaft slender, of moderate length, about 125% of nasobasal length; rostral base 12% of nasobasal length (fig. 4, Table 2); rostral appendices long, flattened anteriorly, subtriangular in cross-section and abutting (rather than fused to) rostral shaft posteriorly; propterygia of pectoral girdle reaching rostral node; nasal capsules very large, ovoid, set at about 26° to transverse axis of neurocranium; foramen for profundus nerve near antero-lateral margin of nasal capsules; preorbital process poorly developed; postorbital process poorly developed and barely distinct from pterotic process; anterior fontanelle very narrow, with acutely rounded apex and bilobed posterior margin, extending to leading edge of nasal capsule; posterior fontanelle indistinct (not visible in radiographs and only detectable after staining and dissection), irregularly notched due to broad margin of acellular perichondrial tissue, fontanelle covered with dense fibrous connective tissue; basal fenestra kidney-shaped; anterior cerebral vein foramen antero-dorsal to optic nerve foramen and above orbito-nasal canal foramina; oculomotor nerve foramen dorsal to optic stalk; jugal arches weak; basal plate and internasal plate relatively narrow, about 28.7% and 12.5% of nasobasal length respectively.

Scapulocoracoid of female moderately short, longer than deep, tapering slightly posteriorly; lateral face expanded slightly between mesocondyle and metacondyle (fig. 5, Table 3); anterior bridge wide, thin, strongly depressed; anterior dorsal fenestra slightly larger than anterior ventral fenestra; scapular process elevated above antero-dorsal margin; anterior corner weakly angular, antero-lateral margin very slightly convex; rear corner not extended distally; mesocondyle slightly depressed; postdorsal fenestra moderately expanded, oval; 3 postventral foramina, central smallest.

Pelvic girdle with short prepelvic processes (fig. 6); iliac processes moderately well developed, strongly recurved; ischiopubic region relatively narrower in males than in females, with straight anterior margin in males and weakly convex margin in females, but with strongly concave posterior margins in both sexes; iliac region with 2–3 obturatorial foramina.

Claspers long, very slender, proximal to and not expanded at origin of glans (fig. 7); without dermal denticles or pseudo-siphon; glans weakly depressed, moderately expandable. Inner dorsal lobe with pseudorhipidion extending from level of hypopyle and medial to slit, to about distal quarter of glans; continuing distally almost to glans margin as a fold of integument; lobe with deep cleft lateral to pseudorhipidion; slit proximal to cleft; spur and flag absent. Ventral lobe without shield; pela well developed, extending from level of hypopyle into distal half of glans; projection slightly curved laterally, extending for almost half length of glans from beneath pela to its pointed, naked distal tip near glans margin; spike disc-shaped with sharp, naked lateral and distal margins, ventral to projection, partly covered by sentina but disto-lateral margin visible. Axial cartilage with a slender conical tip; extending well beyond other cartilages (fig. 8). Dorsal marginal cartilage not expanded distally; with a truncate distal border (with the dorsal terminal 2 cartilage) and a long, slender, distomedial extension forming the pseudorhipidion. Dorsal terminal 1 cartilage relatively narrow and band-like with irregular anterior and posterior margins; located at about midlength of pela and enveloping axial cartilage. Dorsal terminal 2 cartilage rather broad, almost spatulate distally; connected to medial aspect of axial cartilage by well-developed terminal bridge and loosely connected to tip of axial by connective tissue. Ventral marginal cartilage not flared laterally at level of hypopyle; extending almost to distal margin of accessory terminal 2 (as component projection). Ventral terminal cartilage J-shaped; proximo-medial condyle articulating with ventral marginal cartilage, disto-medial extension articulating with tip of axial cartilage; inner limb seated near articulation of accessory terminal 2 and ventral marginal cartilages; acute proximal tip not forming component eperon; disto-lateral margin strongly curved inward and not forming component shield. Accessory terminal 1 cartilage lacking, possibly fused with ventral terminal cartilage to form component projection. Accessory terminal 2 cartilage with large disc-shaped distal extension forming component spike; articulating with postero-medial margin of ventral marginal cartilage.

Colour in preservative. Dorsal surface straw-coloured to pale greyish-yellow, minute melanophores scattered widely over most of surface; ventral surface whitish with translucent skin, palest near margins of disc, minute melanophores lightly scattered over tail. In life, paler, creamish to white above, pinkish over body cavity and head; eyes black; tail brilliant white; skin totally transparent ventrally, viscera distinct.

Size. A small skate attaining at least 448 mm TL and 222 mm disc width; males maturing larger than 360 mm TL.

Distribution. Known from the south-eastern Indian Ocean on the central western sector of the Australian continental slope (between Shark and Nickol Bays, Western Australia), in depths of 590–760 m. Apparent stenobathic and narrow geographic

ranges may not be an artefact; trawl data from depths shallower and deeper, and in areas adjacent the geographic range, included other sympatric rajoid species, but excuded *N. hirticauda*.

Etymology. A combination of the Latin *hirtus* (rough or bristly) and *cauda* (tail) in allusion to the dense coverage of fine denticles on both surfaces of the tail. Known by the vernacular 'ghost skate'.

Remarks. *Notoraja hirticauda* fits the diagnosis of *Notoraja* as defined by Stehmann (1989) and McEachran and Last (1994), except that the tail is unusually thorny (compared to thorns absent or in a medial row in other *Notoraja* species), the rostral cartilage (including node) is distinctly longer than the nasobasal length (rather than about equal in length), and the rostral appendices are subtriangular posteriorly and abut the rostral shaft (rather than plate-like and running closely parallel to the shaft). *Notoraja hirticauda* is further distinguished from its nominal congeners *N. laxipella, N. ochroderma, N. subtilispinosa*, and *N. tobitukai*, in proportional measurements, lacking oronasal pits, coloration, and in some skeletal structures. Of these species, *Notoraja hirticauda* exhibits greatest overall similarity to *N. subtilispinosa*. It is also superficially similar to *N. laxipella* but has tail thorns (otherwise absent), a well-developed anterior bridge in the scapulocoracoid (rather than thin or absent), a robust terminal bridge in the clasper (rather than incomplete), and fewer precaudal vertebrae. The relatively long snout of *N. hirticauda* (preorbital snout length 12.4–13.7%) is more typical of *N. laxipella* (13.4–14.7% TL) than the other *Notoraja* species (10.8–12.5% TL). A longer snout is also evident from the prenasal length (10.1–11.0% vs. 8.9–10% TL in these other *Notoraja* species) and in the shape of the neurocranium (rostral cartilage length 125% in *N. hirticauda* vs. 88–92% of nasobasal length in *N. tobitukai* and *N. subtilispinosa*). *Notoraja ochroderma* has a relatively long rostral cartilage (ie. 104% of nasobasal length; McEachran and Last, 1994) but it is still much shorter than that of *N. hirticauda*. *Notoraja ochroderma* and *N. hirticauda* (combined orbit and spiracle lengths 3.5–4.7% TL), and *N. hirticauda* (4.2–5% TL), have smaller orbits and spiracles than *N. tobitukai* and *N. subtilispinosa* (5–5.7% TL).

Members of the genus *Notoraja* also exhibit significant interspecific variation in the mouth and tail sizes, the pelvic-fin shape, and the gill-slit size and interspacing. *Notoraja hirticauda* appears to have smaller gill slits (eg. first gill-slit width 0.8–1.2% vs. 1.2–1.5% TL) and narrower intergill distances (eg. width between first gill slits 10.4–11.7% vs. 11.5–13% TL) than *N. subtilispinosa*. The anterior pelvic-fin lobe varies greatly from slightly shorter in mature males (anterior 93–96% of posterior lobe) to slightly longer than the posterior lobe in most females (typically 104–110%) of *N. hirticauda*. The anterior lobe is subequal or longer in *N. subtilispinosa* and *N. tobitukai* (anterior 100–117% in posterior lobe) and shorter than the posterior lobe in *N. ochroderma* (anterior 76–90% in posterior lobe). *Notoraja hirticauda* and *N. tobitukai* (tail width at pelvic-fin tips 3.2–3.9% TL) have a slightly broader tail than *N. subtilispinosa* and *N. laxipella* (width at pelvic-fin tips 2.2–3.1% TL). The four *Notoraja* species appear to have larger mouths than *N. laxipella* (5.7–7.2 vs. 4.8–5.5).

The pectoral-fin radial and trunk vertebral counts of *N. hirticauda* closely resemble those of *N. subtilispinosa*, *N. tobitukai* and *N. laxipella* (ie. 24–27 and 61–67 for vertebral and radial counts respectively). Both counts are higher for *N. ochroderma* (30–32 and 87–89 for vertebral and radial counts respectively). Similarly, the scapulocoracoid of *N. hirticauda* is more similar to those of *N. subtilispinosa*, *N. tobitukai* and *N. laxipella* than to that of *N. ochroderma* which has a relatively more elongate scapulocoracoid with a very large, horizontally expanded post-dorsal fenestra. *Notoraja hirticauda* has three postventral foramina like female specimens of *N. subtilispinosa* and *N. laxipella* examined to date (four in *N. tobitukai* and five in *N. ochroderma*). The pelvic girdle of *N. hirticauda* most closely resembles that of *N. tobitukai*. In both species, the anterior contour of the ischiopubic bar is slightly convex and the prepelvic processes are short and rather robust. The prepelvic processes of *N. subtilispinosa* and *N. ochroderma* are much more slender and the anterior contour of the ischiopubic bar of the latter is straight (McEachran and Last, 1994). As discussed above, the neurocranium of *N. hirticauda*, like *N. laxipella*, has a relatively long rostral shaft and appendices compared to other species of *Notoraja* but the presence of jugal arches is shared by *N. laxipella* and all members of the genus except *N. ochroderma*.

The fontanelle structure of the neurocranium of *N. hirticauda* differs from the normal condition found in skates. A posterior fontanelle is well developed in most rajoids. Stehmann (1989) could not detect either anterior or posterior fontanelles in the neurocranium in radiographs of the holotype of *N. subtilispinosa*, and Ishihara and Stehmann (1990) observed only an anterior fontanelle in radiographs of a second specimen from Indonesia. Similarly, only the anterior fontanelle was detectable in X-rays of the neurocrania of *N. hirticauda* types, although an ill-defined, posterior aperture overlain with smooth uncalcified cartilage and dense connective tissue was evident from dissection. A similar, poorly-defined posterior fontanelle exits in *N. laxipella*. In comparison, the posterior fontanelles of other related Australasian skates (ie *Notoraja ochroderma*, *Irolita*, *Pavoraja* and *Brochiraja*) are sharply defined in radiographs (Last and McEachran, unpubl.).

The rostral appendices are considered to be important evolutionary characteristics (McEachran, 1984: McEachran and Miyake, 1990). Three *Notoraja* species (*N. tobitukai*, *N. subtilispinosa* and *N. ochroderma*) are considered to possess plate-like rostral appendices (Stehmann, 1989; McEachran and Last, 1994). These structures are thickened, almost triangular in cross-section distally in *N. hirticauda*, and more closely resemble the subconical appendices found in *N. laxipella* and *Brochiraja*. Further inspection of the neurocranium of *N. laxipella* revealed a relatively thinner, rostral cartilage separated slightly from its appendices (rather than continuously abutting them as in *N. hirticauda*).

The external form of the clasper of *N. hirticauda* is consistent with the general type found in *Brochiraja* and *Notoraja*, except for *N. ochroderma*, which has an eperon and a shield formed by the sharp proximal margin of the ventral terminal cartilage (McEachran and Last, 1994). The dorsal terminal 1 cartilage, small in *N. hirticauda*, is absent in *N. ochroderma* and sometimes absent in *N. tobitukai*. McEachran and Last (1994) suggested that the "rhipidion" of *Notoraja*, *Pavoraja* and *Irolita* is structurally different and probably not homologous with the

rhipidion of Ishiyama (1958, 1967), Stehmann (1970) and Hulley (1972), that occurs in the majority of skate taxa in Group II (McEachran and Miyake, 1990). Ishiyama (1958, 1967) applied the terms pent and pela to this structure but since pent has been proposed for a separate component, the "rhipidion" of Group I should be called the pela to avoid further confusion.

Within *Notoraja*, only *N. ochroderma* and *N. hirticauda* are whitish on both dorsal and ventral surfaces. *N. ochroderma* possesses oronasal pits which are lacking in all other *Notoraja* species. The dorsal squamation of *N. hirticauda*, consisting of fine, erect but slightly recurved denticles, is similar to *N. subtilispinosa*, *N. ochroderma* and *N. laxipella*. Also, the tail of *N. hirticauda* and *N. ochroderma*, unlike the other two species, has irregular rows of small thorns. However, unlike *N. ochroderma*, the ventral surface of the tails of *N. hirticauda* and the other *Notoraja* species are covered in denticles.

Much of the pavorajine skate fauna of the Indo-Pacific remains undescribed. Within the known fauna, *N. hirticauda* appears to be much more similar to *N. subtilispinosa* and *N. laxipella* than either *N. ochroderma* or *N. tobitukai*, and the supraspecific structure of the *Notoraja* group needs further investigation. McEachran and Last (1994) noted that *N. ochroderma* did not fit the synapomorphy scheme of either *Notoraja* or *Pavoraja* but tentatively placed it in *Notoraja* as a conservative measure. Yearsley and Last (1992), who demonstrated similarities between the subgenus *Insentiraja* and *Notoraja*, temporarily placed the former in *Pavoraja* based on McEachran's earliest synapomorphy scheme (1984) and stressed the need for a review of Indo-Pacific pavorajines. A study of the relationships of Australian and New Zealand skates is now in progress by McEachran and Last (unpubl.).

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Nomenclature and distribution of the species of the porcupinefish family Diodontidae (Pisces, Teleostei)

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Abstract

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The tetraodontiform fish family Diodontidae is widely distributed in tropical and temperate marine waters. The family has more than 70 nominal species, over 60% of which were described in the 100 years following Linnaeus. As a consequence, many descriptions are less than detailed, and many types are no longer extant, if they existed at all. The high incidence of synonymy, the many 'old' descriptions and the wide geographical distributions of the species has led to a great deal of confusion. The present study, based on examination of diodontid holdings in 29 major collections, and including the extant types of all but two of the nominal species, attempts to clarify the nomenclature and distribution of the species of the family. Although some species boundaries are not entirely clear, only 18 or 19 of the nominal species are herein regarded as valid (one as a subspecies). Tentative assignments of species to genera maintain current usage. Final assignments to genera must await a cladistic analysis of relationships within the family. Four species are circumtropical, four species (plus a subspecies) are confined to the Atlantic and appear to form a species group, four species are widely distributed in the tropical Indo-Pacific, two species are confined to tropical Australasia, and three are endemic to temperate Australia. One species described from New Zealand either occurs also in Australia, or is a synonym of an Australian species. Synonymies, a key to the recognized species and a table of the identities of nominal species are provided.

Keywords Tetraodontiformes, burrfish, *Allomycterus*, *Chilomycterus*, *Cyclichthys*, *Dicotylichthys*, *Diodon*, *Lophodiodon*, *Tragulichthys*

Introduction

The porcupinefish family Diodontidae contains about 19 species in seven or eight genera of warm to temperate seas. There are about 75 nominal species in the family, and several of the species have very wide distributions. The species are conspicuous, readily captured, of unusual morphology, and have been the focus of interest by naturalists from ancient times. Several species have pelagic stages that reach large sizes and differ in appearance from the demersal adults. All this has led to a great deal of confusion as to the number of species, their distributions and the correct names for them. The purpose of this paper is to clarify a number of nomenclatural issues and the distributions of the species. Due to their wide distributions, the species are obvious targets for molecular genetic studies, and it is reasonable to expect that some taxa that are currently, on the basis of morphology alone, considered to represent a single, widespread species will be subdivided once genetic studies are undertaken. Conversely, some Atlantic taxa have less than clear separations and may eventually be considered conspecific. Therefore, it is important to lay some groundwork for these expected future studies.

This paper lists the senior synonym of each morphologically-defined species, followed by the junior synonyms. Brief justifications for synonymies are provided, as are descriptions of the distribution of the species based on material examined or on identifiable literature records. In addition to the key provided here, regional keys to the species, and illustrations of them, can be found in Leis (1986, ref. 5686 – western Indian Ocean); Leis (2001, ref. 26318 – western central Pacific Ocean: this key also covers all species in the eastern Indian Ocean); Allen and Robertson (1994, ref. 22193 – eastern Pacific Ocean); Leis (2003, ref. 27121 – western central Atlantic Ocean); Leis (in press, eastern central Atlantic Ocean). The key in Leis (2001, ref. 26318) includes all Indo-Pacific species and genera recognized herein, except the two temperate Australasian species *Diodon nicthemerus* Cuvier and *Allomycterus pilatus* Whitley (for these, see Kuiter, 1993, ref. 23929, or Gomon et al., 1994, ref. 22532).

Materials and methods

Abbreviations of fins are as follows: D, dorsal; A, anal; P, pectoral; C, caudal. The spines mentioned are the dermal spines (i.e., modified scales): fins of diodontids lack spines. These

dermal spines have subdermal bases (or roots) that have either two approximately opposing bases upon which the exposed spine pivots when it elevates, or three (occasionally four) broadly more or less equidistantly spaced bases that render the exposed spine immobile. The exposed portion of the spine varies in length and shape, but erectile spines are generally round in cross-section, whereas fixed spines can vary from round to compressed in cross-section. See Leis (1978, ref. 5529; 1986, ref. 5686; or 2001, ref. 26318) for more information on spine morphology. Behind the massive beak-like jaws of diodontids is a grinding, or trituration, plate formed by the fused premaxillae and dentaries. This plate is often armed with transverse plates of teeth, called trituration teeth.

Specific information on types is included only if it supplements or corrects information in Eschmeyer (2005; 17 Oct 2005 version). To keep the literature cited list to a manageable length, it includes only references not included in Eschmeyer's (2005) on-line database (http://www.calacademy.org/research/ichthyology/catalog/fishcatmain.asp). The Eschmeyer reference number is included with the text citation. Information on *Diodon* is included in Leis (1978, ref. 5529) and in Leis and Bauchot (1984, ref. 12539). For *Diodon*, only information on species described since 1978 and information updating species distributions is included here.

I examined specimens of diodontids from the following institutions (codes after Leviton et al., 1985, ref. 9683): AMS, ANSP (loans based on holdings list), BMNH, BPBM, CAS, CSIRO, FAKU, FMNH (loans based on holdings list), FRSKU, LACM, MCZ, MNHN, NMNZ, NMV, NSMT, NTM, QM, RMNH, ROM, RUSI, SAMA, SIO, SMF, UA, USNM, WAM, ZMA, ZMB, ZMUC. Distributions are based primarily on museum specimens examined, but are supplemented with reliable literature accounts.

Results

Family Diodontidae

Diagnosis. Small to medium-sized fishes to 1 m in length, commonly 20–50 cm. Body wide and capable of great inflation, covered with massive spines that may be quite long; spines with large bases, or roots, under the skin; long spines usually erectile and two-rooted, short spines usually fixed in erect position by their three-rooted bases. Head broad and blunt; gill opening a relatively small, vertical slit immediately before pectoral-fin base; nasal organ usually in small tubes located in front of large eyes; mouth large, wide and terminal; teeth fused to form a strong, beak-like crushing structure without a median suture dividing the upper and lower jaws into left and right halves. Dorsal and anal fins without spines, set far back on body, and, like caudal fin, generally rounded; most fin rays branched; bases of fins often thick and fleshy; no pelvic fins. Lateral line inconspicuous. No normal scales.

Genera. There is no generally agreed-upon allocation of species to the nominal genera, nor is there any cladistic analysis of the family or any subset of it. Most authors recognize *Diodon* (five species, revised by Leis, 1978, ref. 5529) for species in which nearly all the dermal spines are erectile. Four monotypic Indo-Pacific genera, three of which are confined to Australasia, contain species that have a mixture of fixed and erectile spines – *Allomycterus*, *Dicotylichthys*, *Lophodiodon* and *Tragulichthys* – are usually recognized (see Gomon, 1994, ref. 22532 ; Leis, 2001, ref. 26318) and are in this paper. *Chilomycterus* sensu lato (about ten species with nearly all dermal spines fixed and immovable) has been more problematical. Tyler (1980, ref. 4477) recognized three groupings of *Chilomycterus*: 1) 'Atlantic *Chilomycterus*' (five species confined to the Atlantic, and called by him *antennatus, antillarum, mauretanicus, schoepfii* and *spinosus*); 2) what I call herein 'Circumtropical *Chilomycterus*' (a circumtropical group considered by Tyler to consist of four species called by him *affinis, atinga, reticulatus* and *tigrinus*); and 3) 'Indo-Pacific *Chilomycterus*' (considered by Tyler to consist only of *orbicularis*). I agree with Tyler (1980, ref. 4477) that nominal species in each of these three groups are morphologically more similar to each other than they are to species in the other groups. The type species of *Chilomycterus* is *Diodon reticulatus* Linnaeus (1758, ref. 2787); thus, if these groupings prove to be valid at the generic level, the circumtropical group becomes *Chilomycterus*, and I use it in that sense herein. *Cyclichthys* typically is used for several Indo-Pacific species (including two not mentioned by Tyler [1980, ref. 4477]), and the type of *Cyclichthys* is the Indo-Pacific *orbicularis;* thus, the Indo-Pacific grouping can be considered *Cyclichthys* for the purposes of this paper. The Atlantic group of species, regarded by Tyler to be the most phylogenetically basal, is nearly always included in *Chilomycterus*. If these Atlantic species were removed from *Chilomycterus*, the generic name available for them is *Lyosphaera*, based on the unique pelagic stage found in at least some members of this group. Unfortunately, the identity of the type species is not clear (on the basis of distribution, *schoepfii* seems most likely). *Lyosphaera* has not been used as a generic name for these five Atlantic species, and until a full cladistic analysis is performed on the group, its use is not recommended. For the purposes of this paper, I use Tyler's term, "Atlantic *Chilomycterus*", to identify this grouping.

Chilomycterus (ex Bibron) Brisout de Barneville, 1846 (sensu stricto)

Chilomycterus (ex Bibron) Brisout de Barneville, 1846 (type species, *Diodon reticulatus* Linnaeus)

Cyanichthys Kaup, 1855 (type species is *D. coeruleus* [non-*D. caeruleus* Quoy and Gaimard] Kaup = *D. reticulatus* Linnaeus, 1758)

Diagnosis. All spines fixed, with long subdermal bases but short or absent external spines (relatively smaller in larger individuals); some spines on top of head with 4 bases; 10 C rays; 21–23 vertebrae; heavy jaw teeth, but trituration teeth few; no tentacles; nostril in adult an open, cup-shaped organ with reticulations; 1 or more spines wholly on dorsal surface of caudal peduncle; fins spotted; no large blotches on dorsal surface of head or trunk. Some additional osteological characters are given by Tyler (1980, ref. 4477).

The type species of *Chilomycterus* is *Diodon reticulatus* Linnaeus (1758, ref. 2787). *Cyanichthys coeruleus* Kaup (1855, ref. 2571) was based on an unregistered BMNH specimen of 43 mm SL (see also Günther, 1870, ref. 1995). Although Kaup

Table 1. Nominal diodontid species and their current identity. *Allomycterus jaculiferus* McCulloch is included because of confusion about its identity. Bibliographic details can be found in Eschmeyer (2005).

Nominal species	Current identity
affinis Günther 1870	*Chilomycterus reticulatus* (Linnaeus 1758)
antennatus Cuvier 1816	*Chilomycterus antennatus* (Cuvier 1816)
antillarum Jordan & Rutter 1897	*Chilomycterus antillarum* Jordan & Rutter 1897
areolatus Gronow in Gray 1854	*Chilomycterus schoepfii* (Walbaum 1792)
armillatus Whitley 1933	*Diodon hystrix* Linnaeus 1758
atinga Bloch 1785	*Diodon hystrix* Linnaeus 1758
atringa Linnaeus 1758	not identifiable
bertolettii Lema Lucena Saenger & Oliveria 1979	*Diodon eydouxii* Brisout de Barneville 1846
bleekeri Günther 1910	*Diodon liturosus* Shaw (ex Lacepède) 1804
blochii Castelnau 1872	*Diodon nicthemerus* Cuvier 1818?
bocagei Steindachner 1866	*Diodon holocanthus* Linnaeus 1758
brachiatus Bloch and Schneider 1801	*Diodon hystrix* Linnaeus 1758
briareos Metzelaar 1919	*Chilomycterus antennatus* (Cuvier 1816)
caeruleus Quoy & Gaimard 1824	*Cyclichthys orbicularis* (Bloch,1785)
californiensis Eigenmann 1891	*Chilomycterus reticulatus* (Linnaeus 1758)
calori Bianconi 1854	*Lophodiodon calori* (Bianconi 1854)
cornutus Kaup 1855	*Chilomycterus spinosus spinosus* (Linnaeus 1758)?
digitalis Breder 1927	*Chilomycterus antennatus* (Cuvier 1816)
diversispinis Bleeker (ex Verreaux) 1865	*Dicotylichthys punctulatus* Kaup 1855
echinatus Linnaeus 1758	*Chilomycterus reticulatus* (Linnaeus 1758)
eydouxii Brisout de Barneville 1846	*Diodon eydouxii* Brisout de Barneville 1846
fuliginosus deKay 1842	*Chilomycterus schoepfii* (Walbaum 1792)
galapagosensis Klausewitz 1958	*Chilomycterus reticulatus* (Linnaeus 1758)
geometricus Bloch & Schneider 1801	*Chilomycterus antillarum* Jordan & Rutter 1897
grandoculis Ogilby 1910	*Tragulichthys jaculiferus* (Cuvier 1818)
hardenbergi de Beaufort 1939	*Cyclichthys hardenbergi* (de Beaufort 1939)
holocanthus Linnaeus 1758	*Diodon holocanthus* Linnaeus 1758
hystrix Linnaeus 1758	*Diodon hystrix* Linnaeus 1758
jaculiferus (non-Cuvier) McCulloch 1921	*Allomycterus pilatus* Whitley 1931
jaculiferus Cuvier 1818	*Tragulichthys jaculiferus* (Cuvier 1818)
lineatus Bloch & Schneider 1801	*Chilomycterus schoepfii* (Walbaum 1792)
lissogenys Günther 1910	*Chilomycterus reticulatus* (Linnaeus 1758)
liturosus Shaw (ex Lacepède) 1804	*Diodon liturosus* Shaw (ex Lacepède) 1804
maculato-striatus Mitchill 1815	*Chilomycterus schoepfii* (Walbaum 1792)
maculatus Duméril 1855	*Diodon liturosus* Shaw (ex Lacepède) 1804
maculatus Hermann 1804	not identifiable
maculifer Kaup 1855	*Diodon holocanthus* Linnaeus 1758?
mauretanicus Le Danois 1954	*Chilomycterus spinosus mauretanicus* (Le Danois 1954)
melanopsis Kaup 1855	*Diodon eydouxii* Brisout de Barneville 1846
meulenii Walbaum 1792	*Chilomycterus schoepfii* (Walbaum 1792)
multimaculatus Cuvier 1818	*Diodon holocanthus* Linnaeus 1758
myersi Ogilby 1910	*Dicotylichthys punctulatus* Kaup 1855
nicthemerus Cuvier 1818	*Diodon nicthemerus* Cuvier 1818
nigrolineatus Ayres 1842	*Chilomycterus schoepfii* (Walbaum 1792)
nigropunctatus Smith 1957	*Lophodiodon calori* (Bianconi 1854)
novemmaculatus Cuvier 1818	*Diodon holocanthus* Linnaeus 1758
nudifrons Jenkins 1904	*Diodon hystrix* Linnaeus 1758
orbe Lacepède 1798	*Chilomycterus spinosus spinosus* (Linnaeus 1758)
orbicularis Bloch 1785	*Cyclichthys orbicularis* (Bloch,1785)
orbitosus Poey 1875	*Chilomycterus antillarum* Jordan & Rutter 1897?
paraholocanthus Kotthaus 1979	*Diodon holocanthus* Linnaeus 1758
parcomaculatus von Bonde 1923	*Cyclichthys orbicularis* (Bloch,1785)
pentodon Atkinson in Bryant 1888	*Chilomycterus schoepfii* (Walbaum 1792)
pilatus Whitley 1931	*Allomycterus pilatus* Whitley 1931
pilosus Mitchill 1815	*Diodon holocanthus* Linnaeus 1758
plumierii Lacèpede 1798	*Diodon hystrix* Linnaeus 1758?
punctatus Cuvier 1818	*Diodon hystrix* Linnaeus 1758
punctulatus Kaup 1855	*Dicotylichthys punctulatus* Kaup 1855
quadradicatus Waite 1900	*Chilomycterus reticulatus* (Linnaeus 1758)
quadrimaculatus Cuvier 1818	*Diodon holocanthus* Linnaeus 1758
reticulatus Linnaeus 1758	*Chilomycterus reticulatus* (Linnaeus 1758)
rivulatus Cuvier 1818	*Chilomycterus schoepfii* (Walbaum 1792)
schoepfii Walbaum 1792	*Chilomycterus schoepfii* (Walbaum 1792)
sexmaculatus Cuvier 1818	*Diodon holocanthus* Linnaeus 1758
spilostylus Leis & Randall 1982	*Cyclichthys spilostylus* (Leis and Randall 1982)
spinosissimus Cuvier 1818	*Diodon hystrix* Linnaeus 1758
spinosus Linnaeus 1758	*Chilomycterus spinosus spinosus* (Linnaeus 1758)
tigrinus Cuvier 1818	*Chilomycterus reticulatus* (Linnaeus 1758)
torosus Larrañaga 1923	*Chilomycterus spinosus spinosus* (Linnaeus 1758)?
totara Curtiss 1938	*Diodon hystrix* Linnaeus 1758
triedricum Cuvier 1818	*Diodon hystrix* Linnaeus 1758
verrucosus deKay (ex Mitchill) 1842	*Chilomycterus schoepfii* (Walbaum 1792)
whiteleyi Phillipps 1932	*Allomycterus pilatus* Whitley 1931?

identified this specimen as *D. coeruleus* Quoy and Gaimard (an alternate spelling of *caeruleus*), it is clearly a juvenile, pelagic specimen of *Chilomycterus reticulatus* (Linnaeus). Kaup (1855, ref. 2571) asserted the specimen was from New Guinea, but according to Günther (1870, ref. 1995) the locality of the specimen "was never known at the British Museum". A single species (see below).

Chilomycterus reticulatus (Linnaeus, 1758)

Diodon reticulatus Linnaeus, 1758: 334 (India)
Diodon echinatus? Linnaeus, 1758: 335 (India)
Diodon tigrinus Cuvier, 1818: 127, pl. 6 (Moluccas)*
Chilomycterus affinis Günther, 1870: 314 (unknown locality)*
Chilomycterus californiensis Eigenmann, 1891: 1133 (San Pedro, California)*
Euchilomycterus quadradicatus Waite, 1900: 208 (Lord Howe I.)*
Chilomycterus lissogenys Günther, 1910: 476, pl. 179 (Hawaii)
Chilomycterus galapagosensis Klausewitz, 1958: 82, fig. 7 (Galapagos Is.)*
*extant type

Based on examination of 55 museum specimens, including extant types, from throughout its range (circumglobal in warm waters), I can find no morphological differences among the different nominal species or among geographic locations. There is variation in colour pattern similar to that found in the circumtropical *Diodon holocanthus* (see Leis, 1978, ref. 5529) but, like that species, it is not obviously geographically based. Spotting on the body is variable, although usually present to some degree, but smaller spots are present on at least some, and usually all, of the fins. The pelagic juvenile phase has a distinctly different colour phase from the benthic adult. The species remains pelagic to about 200 mm SL, thus providing ample opportunity for dispersal and maintenance of genetic continuity. Therefore, I regard Tyler's group of 'circumglobal *Chilomycterus*' to consist of a single species. The rationale for calling this species *Chilomycterus reticulatus* (Linnaeus) follows.

Diodon atringa Linnaeus (1758, ref. 2787) is frequently regarded as a synonym (often the senior synonym) of this species. This name is often misspelled *atinga* by authors. This is clearly incorrect: Linnaeus used the spelling *atringa* in both his tenth and twelfth editions. Nelson et al. (2004, ref. 27807) recently explained why *atringa* is correct; and Eschmeyer (2005) used *atringa*. To avoid confusion with *D. atinga* Bloch (1785, ref. 4866), a synonym of *D. hystrix*, I herein use the spelling *atringa* for the Linnaean species, regardless of the spelling used by any subsequent author. Unfortunately, *D. atringa* Linnaeus is not identifiable. There is no type, and Linnaeus' description could apply to any of several species of *Chilomycterus* or *Cyclichthys* (including *C. reticulatus, C. antennatus* or *C. spinosus*), and the same is true of Artedi (1738), the only source cited by Linnaeus, and the pre-Linnaean authors cited by Artedi. Artedi, 1738 mentioned that the fins of his "Ostracion bidens sphaericus…", upon which Linnaeus based his *D. atringa,* were spotted, but large individuals of *C. antennatus* (Cuvier, 1816, ref. 993) also have spotted fins (see below), so this is not diagnostic, as is often assumed. Linnaeus (1766, ref. 2786) cited a plate in Seba (1759, ref. 18716) that represents either *C. reticulatus* or *C. antennatus*. Brisout de Barneville (1846, ref. 296) was the first author to express a clear opinion, and considered *D. atringa* Linnaeus to be synonymous with *D. orbe* Lacepède (1798, ref. 2708). The latter was based on a specimen from Brazil – no longer extant – that is clearly identifiable as the Atlantic *Diodon spinosus* Linnaeus (see below). Le Danois (1959, ref. 12003) considered *atringa* Linnaeus to be approximately equivalent to Tyler's "Atlantic *Chilomycterus*" group (which includes *D. spinosus* Linnaeus) with several subspecies roughly equivalent to Tyler's species.

In contrast, *D. reticulatus* Linnaeus (1758, ref 2787) is readily identifiable. Linnaeus based his description on Artedi's "*Ostracion subrotudus…*". Atredi (1738) cited a Willughby (1686) plate of "Orbis muricatus and reticulatus" that is clearly identifiable as *reticulatus* by its colour, general morphology, spine distribution and spine shape. The name *reticulatus* has been in regular use as a senior synonym (in addition to the nine 1870–1926 references listed by Fowler, 1936, ref. 6546 and the >30 post-1985 references listed by Eschmeyer, [2005]: Lowe, 1844, ref. 2833; Brisout de Barenville, 1846, ref. 296; Günther, 1870, ref. 1995; Poey, 1876, ref. 3510; Goode, 1876, ref. 1832, 1877, ref. 13360; Jordan and Gilbert, 1883, ref. 2476; Eigenmann, 1885; Poll, 1959, ref. 12014; Tyler, 1980, ref. 4477; Leis, 1981, 1984; Leis and Bauchot, 1984, ref. 12539). Some authors, apparently following Jordan and Evermann (1898, ref. 2444, have considered *reticulatus* to be a junior synonym of *atringa*, but none have attempted to justify this view. It is clear from Jordan and Evermann's description and key that they incorporated more than one species in their concept of *C. atringa*, including at least *C. reticulatus* and *C. antennatus*. Jordan and Evermann (1898) described *C. atinga* as having dark dorsal blotches and a 'supraocular cirrus', both features that are lacking in *C. reticulatus* (Linnaeus) and in Tyler's 'circumtropical *Chilomycterus*', but present in species of the 'Atlantic *Chilomycterus*' group.

There is a great deal of confusion in the literature as to just what constitutes *C. reticulatus* and *C. atringa*. For much of the 19th century, most authors accepted Bloch's (1785, ref. 21381) concept of *D. atinga* (=*D. hystrix* Linnaeus, 1758, ref. 2787), and although Brisout de Barneville (1846, ref. 296) pointed out that this was in error, the use of *D. atinga* sensu Bloch persisted for some years. Séret and Opic (1981) stated without reasons that *reticulatus* was a synonym of *C. atringa* (Linnaeus), but their illustration of C. *atringa* shows what appears to be *C. antennatus* (Cuvier) (Séret and Opic kindly provided unpublished dorsal and lateral views of the specimen that strengthen this opinion). Similarly, Tortonese (1973, ref. 7192), without comment, listed *reticulatus* as a junior synonym of *atringa*, but, later, Tortonese (in Whitehead et al., 1986, ref. 13677) illustrated as *C. atringa* a specimen of the eastern Atlantic *C. spinosus mauretanicus* (Le Danois), but with spotted fins, a feature I have not observed in the latter species. Smith-Vaniz et al., 1999 (ref. 25013) listed *C. atringa* (Linnaeus) as occurring in Bermuda, but had seen no specimens, stating that their listing was based on Goode's (1876, ref. 1832; 1877, ref. 13360) and Günther's (1870, ref. 1995) records of *C. reticulatus*. Unfortunately, this leads to ambiguity because, Smith-Vaniz et al. (1999, ref. 25013) could be interpreted as considering *reticulatus* a synonym of *atinga*, or as considering that the other authors misidentified their

specimens. Some other workers (e.g., Fowler, 1936, ref. 6546; Lozano Rey, 1952) have included *reticulatus* of authors in their synonymies of *atringa*, but not *reticulatus* Linnaeus (1758, ref 2787), implying that they questioned others' concept of *reticulatus* rather than that they considered *reticulatus* Linnaeus to be a junior synonym of *atringa*.

In more recent years, a view has developed among some American workers that Atlantic individuals of this taxon are *C. atringa*, whereas the Indo-Pacific individuals are either *C. affinis* (Robins et al., 1991, ref. 14237) or *C. reticulatus* (Nelson et al., 2004, ref. 27807), but, again, no justification for this or means of distinguishing the two nominal species has ever been presented. Tyler (1980, ref. 4477) tentatively recognized four species in this complex that have, based on his material examined and text, different distributions: *C. atringa* (western Atlantic); *C. reticulatus* (eastern Atlantic and Indo-Pacific); *C. tigrinus* (western Indian Ocean); and *C. affinis* (Eastern Pacific). However, Tyler (1980, ref. 4477) said that *C. tigrinus* may be the young of *C. reticulatus* (I agree). So confusion about the identity and distribution of these species continues.

In summary, *D. atringa* Linnaeus is unidentifiable, and the post-Linnaean use of the name by various authors has been inconsistent as to what species was being included: at least four species and two multi-species groups have been identified as *D. atringa* by various authors at various times. In spite of the use of *C. atringa* (usually spelled *atinga*) by several authors, the name should be regarded as a nomen dubium, and not used. *Diodon reticulatus* Linnaeus is clearly identifiable, and the use of the name has been remarkably consistent: it should be used for this species.

Diodon echinatus Linnaeus (1758, ref 2787) is seemingly equivalent to his *Chilomycterus reticulatus* (see Leis and Randall, 1982). Linnaeus' (1758, ref 2787) description and the Marcgrave plate to which Artedi (1738) referred could apply to any *Chilomycterus* or *Cyclichthys* species. Linnaeus (1766, ref. 2786) referred to a Seba (1759, ref. 18716) figure that is clearly *Diodon hystrix*. Gronow (1854, ref. 6828), in his account of "*Holocanthus echinatus*", cited a Seba (1759, ref. 18716) figure that is either *Chilomycterus reticulatus* or *C. antennatus*, and a Willughby (1686) figure that clearly represents *C. reticulatus*.

The holotype of *Diodon tigrinus* Cuvier (1818, ref. 18059) is a specimen in the pelagic colour phase of *C. reticulatus*. The species was recognized as a synonym of *C. reticulatus* as long ago as Brisout de Barneville (1846, ref. 296).

Chilomycterus affinis Günther (1870, ref.1995) was based on a specimen of unknown locality that is dried and thickly varnished. The holotype has minimal spotting on the body, and the spines, particularly on the head, are distorted by the taxidermy and insertion of large, blue glass eyes. However, there is nothing outside of the range of *C. reticulatus* variability in this specimen. In the absence of any locality information, it is unclear why most authors regarded this as a Pacific species.

Chilomycterus californiensis was described by Eigenmann (1891, ref. 18744) on the basis of a specimen that he initially did not obtain from the fisherman who captured it "on account of the unreasonable price asked for it". However, the fish was subsequently "procured by the National Museum", and Eigenmann (1892) redescribed and figured it. Therefore, USNM 43860 is in fact the holotype, in spite of Eigenmann's statement in the original 1891 description that "I did not obtain it". The holotype is in the pelagic colour phase of *C. reticulatus*.

Euchilomycterus quadradicatus Waite (1900, ref. 4558) from Lord Howe I. was based on a dried specimen – apparently a beach wash-up – subsequently preserved in ethanol and in poor condition. Although not figured by Waite, Whitley (1952) illustrated the holotype (with some artistic license) clearly showing the caudal-peduncle spine and four-rooted spines on the head that in combination are diagnostic of *Chilomycterus reticulatus*.

Chilomycterus lissogenys Günther (1910, ref. 14460) was based on an illustration by Garrett of a Hawaiian fish. Although Garrett omitted some of the spines on the side of the head, he clearly showed the spine on the caudal peduncle that is characteristic of *C. reticulatus*. The illustration showed relatively few spots on the body, but heavily spotted fins, a condition well within the range of colour variation in this species.

The description and photo of *Chilomycterus galapagosensis* Klausewitz (1958, ref. 12080) are clearly that of *C. reticulatus*. The description of the nostrils alone is diagnostic. Klausewitz distinguished his new species from *C. atringa*, which he described as having a supraorbital cirrus and large dorsal blotches (presumably based on the description of Jordan and Evermann [1898, ref. 2244], which was based on more than one species), by its lack of these two characteristics. He distinguished it from *C. californiensis* by colour, but the latter is in pelagic-phase colour, whereas *C. galapagosensis* has typical, spotted demersal colour.

Distribution. Circumglobal in warm temperate to tropical waters:

W Atlantic – 39°N to 24°S

E Atlantic – Madeira (and possibly to Portugal) and Cape Blanco to Angola

W Indian Ocean – South Africa to Tanzania and Reunion, Seychelles and Mauritius

E Indian Ocean – Broome, Western Australia to Bali and Timor

W and central Pacific – Japan to Lord Howe I. and northern New Zealand, to Tuamotos to Hawaii (and in the east Pacific barrier)

E Pacific – San Pedro, California to Chile, Galapagos and Revillagigedos

Occurrences of this species are patchy, and many are based on pelagic juveniles: in particular, adults are unknown from broad areas of the Indo-Pacific. Pelagic juveniles are frequently found poleward of the distribution of adults in areas of strong, poleward currents.

If future work indicates that *C. reticulatus* contains more than one geographically distinct species, several names are available for Indo-Pacific populations, but no name is clearly based on Atlantic material. Most of the extant types are either dried or fixed in alcohol, so it may be possible to obtain genetic data from them that could be helpful. Unfortunately, there are no Linnaean types that might assist in this regard, and Linnaeus' usage of 'habitat in India' cannot be taken at face value in most cases.

Cyclichthys Kaup, 1855

Cyclichthys Kaup, 1855 (type species *Diodon orbicularis* Bloch)

Diagnosis. All but 1 or 2 spines fixed; all spines with 3 bases, except in *C. spilostylus* which has some spines on top of head with 4 bases; 9 C rays; 19–20 vertebrae; no tentacles in adults; nostril in adult a short tube with 2 openings; no spines wholly on dorsal surface of caudal peduncle; no fins spotted; no large blotches on dorsal surface. Some additional osteological characters are given by Tyler (1980, ref. 4477) for *C. orbicularis*.

The type species of this genus is *C. orbicularis* (Bloch, 1785, ref. 21381). Kaup (1855, ref. 2571) included two species in his *Cyclichthys* – *orbicularis* Bloch, and *cornutus* Kaup – but designated neither as type species for the genus. Subsequently, Bleeker (1865, ref. 416) was apparently the first to designate a type species for *Cyclichthys* and chose *orbicularis* Bloch (Eschmeyer, 2005). Fraser-Brunner (1943, ref. 1495) used *Cyclichthys* as a subgenus of *Chilomycterus*. He did not consider *C. hardenbergi*, but included *C. orbicularis*, the "Atlantic *Chilomycterus*" species, and *C. echinatus* non-Linnaeus (= *C. spilostylus*) in his concept of the subgenus *Cyclichthys*. Tyler (1980, ref. 4477) pointed out that *C. orbicularis* had osteological differences from the other diodontids he studied, and placed the species in a group on its own. However, he was not able to examine specimens of *C. spilostylus* or *C. hardenbergi*. Based on external morphology, it appears that *C. orbicularis* differs from other species that have been included in *Cyclichthys* by Fraser-Brunner (1943, ref. 1495), and there is merit in Tyler's placement. If this were done, then a new genus would probably have to be described for *hardenbergi* and *spilostylus*, as they do not appear to be monophyletic with the "Atlantic *Chilomycterus*" species. Pending a cladistic analysis of relationships in the family, I recognize three species in *Cyclichthys*, which has been standard practice in recent years.

Cyclichthys orbicularis (Bloch, 1785)

Diodon orbicularis Bloch, 1785: 73, pl. 127 (Jamaica?, Cape of Good Hope & Moluccas)*?
Diodon caeruleus Quoy and Gaimard, 1824: 201, pl. 65 (fig. 5) (North of New Guinea, 142°E, at the Equator)*
Chilomycterus parcomaculatus von Bonde, 1923: 38, pl. 9 (fig. 2) (Natal, South Africa)
* extant type

Based on examination of 88 lots from throughout the range, including the extant types. There has been no real question as to the identity of this wide-spread and common species.

Although Bloch's (1785, ref. 21381) types might all be lost, his plate showing the arrangement of spines, especially those near the mouth, is diagnostic of this species. There is one specimen of unknown origin in ZMB that may be a syntype of this species (Paepke, 1999, ref. 24282), but definitive evidence is lacking. The alleged type locality of Jamaica appears to be in error.

The holotype of *Diodon caeruleus* Quoy and Gaimard (1824, ref. 3574) was described and figured, and the specimen is extant (see Leis and Bauchot, 1984, ref. 12539), leaving no doubt that it is conspecific with *C. orbicularis* (Bloch).

Chilomycterus parcomaculatus von Bonde (1923, ref. 521) was based on a specimen that was 'inadvertently destroyed' (S.X. Kannemeyer, personal communication, 1/2/80), but the description and figure are diagnostic.

Distribution. Indo-west Pacific
W Indian Ocean – Capetown, South Africa to Red Sea, Oman and Persian Gulf, Maldives, Reunion.
E Indian Ocean – Shark Bay, Western Australia to Burma
W Pacific – southern Japan and Sea of Japan to Sydney, Australia and east to Philippines and New Caledonia.

Cyclichthys hardenbergi (de Beaufort, 1939)

Chilomycterus hardenbergi de Beaufort, 1939: 33–34 (New Guinea)*
*extant type

Based on examination of 21 museum specimens from throughout the limited range, including the holotype. There are no real questions as to the identity of this species: de Beaufort's (1939, ref. 17230) description is diagnostic, and the type is extant. This species has one of the more limited ranges within the family.

Distribution. Indo-Pacific
North-western Australia to the west coast of Cape York, and the south coast of New Guinea. Kailola (1975) also recorded it from the Trobirand Islands.

Cyclichthys spilostylus (Leis and Randall, 1982)

Chilomycterus spilostylus Leis and Randall, 1982: 363, figs 1, 2 (Red Sea)*
*extant types

Based on examination of 23 museum specimens, including the types. This species was mis-identified as *Cyclichthys echinatus* (Linnaeus, 1758, ref. 2787) by some authors (see Leis and Randall, 1982, ref. 8453), but *echinatus* is most likely a synonym of *Chilomycterus reticulatus* (Linnaeus). Other than this, there are no real questions as to the identity of this wide-ranging species. The pelagic stage of this species has a tentacle emerging from each spine. These tentacles are lost at settlement.

Distribution. Indo-Pacific
W Indian Ocean – Capetown, South Africa to Gulf of Elat, Red Sea, Muscat to western India and Mauritius (also a Mediterranean record from Israel by Golani (1993), presumably via Suez Canal)
E Indian Ocean – Northwest Cape, Western Australia to Bali
W Pacific – Southern Japan to Hong Kong, Philippines, New Caledonia, and northern Great Barrier Reef.
E Pacific – Galapagos (single record, including photograph, by Humann [1997], repeated by Grove and Lavenberg [1997], ref. 24023).

"Atlantic *Chilomycterus*"

Lyosphaera Evermann and Kendall, 1898: 131 (type species *Lyospharea globosa* Evermann and Kendall, possibly = *Diodon schoepfii* Walbaum, 1792)

Atinga Le Danois, 1954: 2356. (type species *Diodon atringa* Linnaeus – see Eschmeyer, 2005, and below).

Diagnosis. All spines fixed; all spines with 3 bases; 9 C rays; 19–20 vertebrae; tentacles present on lower jaw and usually over eye; nostril in adult a short tube with 2 openings; no spines wholly on dorsal surface of caudal peduncle; no fins spotted (except in large *C. antennatus*); large blotches present on dorsal surface. Some additional osteological characters are given by Tyler (1980, ref. 4477). At least 2 of the species of this group share the "*Lyosphaera*" larval stage (*antennatus* and the type species of *Lyosphaera*), and others may do the same.

Although the genus *Lyosphaera* Evermann and Kendall (1898, ref. 1281) is available as a generic name for this group, I recommend against its use until a cladistic analysis of the "Atlantic *Chilomycterus*" species and their relationship to other diodontids is undertaken. *Lyosphaera* has never been used in this way, and the identity of the type species is unclear (although most likely to be *schoepfii* based on distribution). The species upon which *Atinga* Le Danois (1954, ref. 6451) is based is unclear. The type species, *D. atringa* Linnaeus (1758, ref. 2787), is not identifiable (see above under *C. reticulatus*). It is clear that Le Danois' (1954, ref. 6451; 1959, ref. 12003; 1962, 21440) concept of *atinga* included a species of the "Atlantic *Chilomycterus*" group, although which species is unclear as her illustrations of *Atinga atinga atinga* in the 1954 paper are of *C. antillarum* (identified as male) and *C. spinosus mauretanicus* (identified as female). In view of this confusion about the identity of the type species, use of *Atinga* Le Danois (1954: ref. 6451) is not recommended. It has been little used since its description.

The "Atlantic *Chilomycterus*" is a group of similar species previously recognized in various ways by Günther (1870, ref. 1995), Le Danois (1959, ref. 12003) and Tyler (1980, ref. 4477). See above regarding the generic status of these species. *Chilomycterus antennatus* is the only member of this group that I can separate on morphological grounds; principally, the development of the fleshy tentacles over the eye. It also has a colour pattern that differs more from the other species of the "Atlantic *Chilomycterus*" group than they do from each other. The other four taxa differ only in colour, and have largely non-overlapping distributions. In all but the case of the very similar forms, *C. spinosus* (Linnaeus, 1758, ref. 2787) and *C. mauretanicus* (Le Danois, 1954, ref. 6451), the distributions do at least seem to come into contact. In contrast, the latter two taxa occur only on opposite sides of the Atlantic and they have only very minor differences in colouration. Hence, I treat these two as subspecies: *Chilomycterus spinosis spinosus* and *Chilomycterus spinosus mauretanicus*. In some cases, colour patterns do exhibit intermediacy. *Chilomycterus schoepfii* adults have a distinctive lined pigment pattern, but the youngest *C. schoepfii* have a colour pattern not unlike that of *C. spinosus* (dark background with lighter, diffuse spotting), and at intermediate sizes, the dark background may have shrunk to a mesh-like pattern with expanded lighter centres similar to that of *C. antillarum*. Similarly, in northern South America, a colour pattern with elements of both *C. spinosus* and *C. antillarum* is present. Examination of the genetics of these "Atlantic *Chilomycterus*" species would be very interesting.

Chilomycterus spinosus spinosus (Linnaeus, 1758)

Diodon spinosus Linnaeus, 1758: 335 (India)
Diodon orbe Lacepède, 1798: 124, pl. 3 (Rio de Janeiro)
Cyclichthys cornutus Kaup, 1855: 231? (unknown locality)*
Tetrodon torosus Larrañaga, 1923: 390? (Uruguay)
*extant type

Based on examination of 24 lots (50–200 mm) from throughout the range, and the extant type of *C. cornutus* Kaup (BMNH 1849.1.15.36).

Linnaeus (1758, ref. 2787) based his description of *Diodon spinosus* on Artedi (1738), who cited an illustration by Willughby (1686). This information is sufficient to determine that the species is one of the "Atlantic *Chilomycterus*" species, but without any lines or small spots on the body. This eliminates *schoepfii*, *antennatus*, *antillarum* and *mauretanicus*, leaving *spinosus* as the unlined, unspotted species of this group.

Lacepède (1798, ref. 2708) provided a figure of *D. orbe* that clearly shows the arrangement of spines and the diagnostic dorsal blotches and lack of small spots or lines on the body. This and the type locality leave no doubt that *Diodon orbe* is conspecific with *C. spinosus* (Linnaeus).

The type of *Cyclichthys cornutus* Kaup (1855, ref. 2571) is a small, stuffed specimen of unknown origin with a thick coat of varnish, but the spine arrangement and presence of a supraocular tentacle show that it is clearly a species of the "Atlantic *Chilomycterus*" group. The visible colour pattern best fits *C. spinosus* (Linnaeus).

Tetrodon torosus Larrañaga (1923: 390 ref. 22561: not seen by me) has been regarded as a synonym of *Chilomycterus spinosus* (Linnaeus) since 1925 (Devincenzi, 1925, ref. 20322, see Eschmeyer, 2005) and I am unaware of any subsequent use of the name. If the synonymy of Devincenzi is correct, Uruguay would represent the southernmost record of *C. spinosus spinosus*.

As noted above, eastern Atlantic specimens of *C. spinosus* have oblique, irregular lines laterally on the trunk and head that are lacking in western Atlantic specimens. Therefore, I have recognized the western Atlantic population as the nominate subspecies and the eastern Atlantic population as *C. spinosus mauretanicus* (Le Danois) (see below).

Distribution. Western Atlantic
From northern coast of South America (Surinam and British Guiana) to Rio de Janeiro, Brazil.

Chilomycterus spinosus mauretanicus (Le Danois, 1954)

Atinga atinga mauretanicus Le Danois, 1954: 2354 (Mauritania, Gulf of Guinea)*
*extant types

Based on examination of 21 lots from throughout the range, including the syntypes. This nominal species is considered a subspecies of *C. spinosus* (Linnaeus) because only minor colour differences separate it from its western Atlantic counterpart. Le Danois (1954, ref. 6451) briefly described this nominal species, apparently inadvertently, in a paper on sexual dimorphism in diodontids, then redescribed it in 1959 (ref. 12003) and provided more information – some of it conflicting – in 1962 (ref. 21440). See Leis and Bauchot (1984, ref. 12539) for information on the status of the types.

Distribution. Eastern Atlantic.

From central Angola to Canary Is. and perhaps Portugal.

Chilomycterus schoepfii (Walbaum, 1792)

Diodon schoepfii Walbaum, 1792: 601 (New York)
Diodon meulenii Walbaum, 1792: 602 (unknown locality)
Diodon geometricus var. *lineatus* Bloch and Schneider, 1801: 513 (New York)
Diodon maculato-striatus Mitchill, 1815: 470 (New York)
Diodon rivulatus Cuvier, 1818: 129, pl. 6 (unknown locality [New York, USA according to Eschmeyer, 2005])*
Diodon nigrolineatus Ayres, 1842: 68 (Brookhaven, Long Island, New York)
Diodon fuliginosus deKay, 1842: 324, pl. 55 (fig. 181) (New York)
Diodon verrucosus deKay (ex Mitchill), 1842: 325, pl. 55 (fig. 1)? (New York)
Holocanthus areolatus Gronow in Gray, 1854: 27? (Cape of Good Hope, South Africa?)
Chilomycterus pentodon Atkinson in Bryant, 1888: 18 (Beaufort, North Carolina, USA)
* extant type.

Based on examination of 62 lots from throughout the range. Unfortunately, I could locate types of only one of the ten nominal species represented here.

Walbaum's (1792, ref. 4572) description of *D. schoepfii* mentions the diagnostic lined colour pattern of this species, as do the descriptions of *Diodon meulenii* Walbaum (1792, ref. 4572), *Diodon geometricus* var *lineatus* Bloch and Schneider (1801, ref. 471), *Diodon maculato-striatus* Mitchill (1815, ref. 13292), *Diodon rivulatus* Cuvier (1818, ref. 18059), *Diodon nigrolineatus* Ayres (1842, ref. 15926), *Diodon fuliginosus* deKay (1842, ref. 1098), *Holocanthus areolatus* Gronow in Gray (1854, ref. 6828) and *Chilomycterus pentodon* Atkinson in Bryant (1888, ref. 13034), thus confirming their identification. The type locality of South Africa for *H. areolatus* provided by Gronow introduces some doubt, but this may well be an error, as there is no diodontid species with a lined colour pattern in that area. *Diodon verrucosus* deKay (ex Mitchill) (1842, ref. 1098) has a pigment pattern similar to that of *C. antillarum*, but, apparently, *C. schoepfii* passes through an early life-history phase with this colour pattern, and the type locality of New York would seem to eliminate the tropical *C. antillarum*, so I tentatively consider *verrucosus* to be a synonym of *C. schoepfii.*

Distribution. Western North Atlantic

From Halifax, Nova Scotia (waif) to Belize (apparently with a gap between southern Texas and Belize) on the mainland and Cuba, Bermuda and Bahamas.

Chilomycterus antennatus (Cuvier, 1816)

Diodon antennatus Cuvier, 1816: 185, pl. 9 (unknown locality)*?
Chilomycterus briareos Metzelaar, 1919: 173, fig. 55 (Lesser Antilles, St Eustatius)*
Lyosphaera digitalis Breder, 1927: 81, fig. 34 (locality unknown Western North Atlantic or W Indies)*
*extant type.

Based on examination of 37 lots, including extant types (see Leis and Bauchot, 1984, ref. 12539, for a discussion of the status of the types of *D. antennatus* Cuvier [1816, ref. 993]). In spite of assertions to the contrary, *C. antennatus* can have spotted fins. Fin spotting in *C. antennatus* begins basally on all fins at about 50 mm SL. The caudal fin becomes mostly or entirely spotted by 100–150 mm SL. Spotting on other fins seems variable, but basal one-third to one-half of the P, D and A fins can be spotted in specimens as small as 127 mm SL, whereas other specimens as large as 200 mm may have spots only on the extreme base on these fins. Because many ichthyologists have assumed that any *Chilomycterus* with spotted fins is *C. reticulatus* (or one of its synonyms), this has led to many misidentifications of *C. antennatus*, and is probably the basis for Jordan and Evermann's (1998, ref. 2244) inclusion of what are apparently characteristics of *C. antennatus* in their description of *C. atringa*.

Aside from colour differences, *C. antennatus* has larger fleshy tentacles, particularly over the eye, than do the other "Atlantic *Chilomycterus*" species. It clearly has a *Lyosphaera* stage larva (Heck and Weinstein, 1978).

Cuvier's (1816, ref. 993) description and figure were diagnostic of the species, and what is probably the type is extant in MNHN (see Leis and Bauchot, 1984, ref. 12539), leaving no doubt about the identity of this distinctive species.

The description and figure of *Chilomycterus briareos* Metzelaar (1919 ref. 2982) clearly refers to C *antennatus*, and the type is extant. The fish has spots on the fins, particularly on the caudal fin, which is common in larger individuals of *C. antennatus.*

In contrast, *Lyosphaera digitalis* Breder (1927, ref. 635), is the young '*Lyosphaera* stage' of this species, virtually lacking spines. Heck and Weinstein (1978) have documented the transition of this distinctive '*Lyosphaera* stage' to the juvenile of *C. antennatus.*

Distribution. Western Atlantic (possibly eastern Atlantic).

W Atlantic – Key West Florida to Panama, Colombia and Tobago, Bermuda, and throughout Caribbean and Antilles.

E Atlantic – no specimens, but see below.

There are persistent reports of *C. antennatus* from the eastern Atlantic, but I have seen no specimens from this area. Where published descriptions or illustrations of "*Chilomycterus antennatus*" from the eastern Atlantic are diagnostic, they are usually of *C. spinosus mauretanicus*, or in some cases *C. reticulatus*. However, there is one published illustration of a fish from Senegal that does appear to be *C. antennatus*, although it is identified in the publication as *C. atringa* (Linnaeus) (Séret and Opic, 1981). Unfortunately, the specimen was not retained (B. Séret, personal communication). When I requested a specimen for study, Séret, who was not in Senegal at the time, kindly arranged for a colleague to send me one: it was *C. spinosus mauretanicus*. Therefore, it is possible that *C. antennatus* does occur rarely in the eastern Atlantic, most likely as a waif from the west. Specimens are needed to confirm this.

Chilomycterus antillarum Jordan and Rutter, 1897

Diodon geometricus Bloch and Schneider, 1801: 513, pl. 96 (coast of Brazil)
Chilomycterus antillarum Jordan and Rutter, 1897: 131 (Kingston, Jamaica)*

* extant type

Based on examination of 41 specimens including extant types. Although D. *geometricus* Bloch and Schneider (1801, ref. 471) is an older name than *C. antillarum* Jordan and Rutter (1897, ref. 10644), and the Bloch and Schneider figure clearly applies to the same species, the name has been little used since its description other than as a junior synonym of either *spinosus* or *schoepfii*. Other than Paepke's (1999, ref. 24282) catalogue of Bloch types (unfortunately, the type of *geometricus* is lost), the most recent correct use of *geometricus* was Günther (1870, ref.1995), and this for only one of his 'varieties' (i.e., beta). In contrast, *C. antillarum* has been widely, almost universally, used for this species (see Eschmeyer, 2005, for 13 publications between 1983 and 2003; in addition, Bailey et al., 1960, ref. 27285; 1970, ref. 27286; Böhlke and Chaplin, 1968, ref. 23150; Randall, 1968; 1996; Tyler, 1977; 1980, ref.4477; Robins et al., 1980, ref. 7111; 1991, ref. 14237; Lieske and Myers, 1994; Cervigón, 1996, ref. 24489; Smith, 1997; Lyczkowski-Schultz, et al., 2005). Because the senior synonym (*geometricus*) has not been used as a valid name after 1899, and because the junior name has been used in at least 25 works published by at least ten authors over the last 50 years, this meets the criteria of Articles 23.9.1 and 2 of ICZN (1999, ref. 26875), and prevailing usage (of *antillarum*) must be maintained. In 2003, I suggested that current usage of *C. antillarum* be maintained in the interests of stability (Leis, 2003, ref. 27121), and here provide evidence that ICZN criteria require this to be met.

Chilomycterus orbitosus Poey (1875: 69, ref. 18564) is clearly a species of the "Atlantic *Chilomycterus*" group, but there is no known extant type. Poey's brief description on Cuban specimens seems to be based on a composite of *C. antillarum* and *C. schoepfii* from Cuba, but perhaps best fits the former. The name *orbitosus* has not been used since its description, as far as I can ascertain. So, even if it could be established that *orbitosus* Poey, 1875 and *antillarum* Jordan and Rutter, 1897 are conspecific, I would recommend against the use of the older *orbitosus* in the interests of stability.

Distribution. W Atlantic.

Florida, Bahamas and Cuba to Venezuela, Barbados and Brazil

Some Brazilian specimens are intermediate in colour between the crisp, dark hexagonal pattern typical of *C. antillarum* and the dark background with vague lighter spots typical of *C. spinosus spinosus*. The significance of this is unknown, and further investigation is required.

Tragulichthys Whitley, 1931

Tragulichthys Whitley, 1931 (type species *D. jaculiferus* Cuvier)

Diagnosis. All spines fixed, except those in pectoral axil which are by far the longest on the body; all spines except those in the P axil with 3 bases; spines long to medium; 9 C rays; 19 vertebrae; no tentacles in adults; nostril in adult a short tube with 2 openings, but may become bifurcate in larger individuals; no spines wholly on dorsal surface of caudal peduncle, but large spines extend over the peduncle nearly to the caudal-fin base; no fins spotted; no large blotches on dorsal surface. Some additional osteological characters are given by Tyler (1980, ref. 4477) as *Diodon jaculiferus*.

The type species of this monotypic genus is *D. jaculiferus* Cuvier (1818, ref. 18059). Most of the spines are fixed in the normal 'burrfish' manner, but those in the pectoral axil, which are by far the longest on the body, are erectile. Some have regarded *Tragulichthys* Whitley (1931, ref. 4673) as a synonym or subgenus of *Diodon* (Fraser-Brunner, 1943, ref. 1495; Tyler, 1980, ref. 4477). But, until a full analysis of the phylogeny of the family is forthcoming, it seems best to maintain current usage and to recognize *Tragulichthys* at the generic level because the only species has a number of morphological differences from the five species normally included in *Diodon*.

Tragulichthys jaculiferus (Cuvier, 1818)

Diodon jaculiferus Cuvier, 1818: 130, pl. 7 ('Indian Ocean via Peron')*

Chilomycterus grandoculis Ogilby, 1910: 19 (Moreton Bay, Queensland)*

*extant type

Based on examination of 50 lots, including extant types, from throughout the range. Aside from confusion regarding the designation of a type species for *Allomycterus* (see below), there have been few nomenclatural issues regarding this tropical Australian species. References to this species from New Zealand are of *Allomycterus pilatus* (see below): *T. jaculiferus* does not occur in New Zealand.

Cuvier's (1818, ref. 18059) description, figure, and the extant type leave no doubt about the identity of this distinctive species. The description of *Chilomycterus grandoculis* Ogilby (1910, ref. 3288) details the diagnostic spination, and the extant type makes it clear that it is conspecific with *T. jaculiferus*.

Distribution. Northern Australia.

From Derby, Western Australia to Darwin (including Rowley Shoals) to Torres Strait and south to Moreton Bay, Qld.

Dicotylichthys Kaup, 1855

Dicotlylichthys Kaup, 1855 (type species *Dicotylichthys punctulatus* Kaup)

Atopomycterus Bleeker (ex Verreaux), 1865 [type species *Atopomycterus diversispinus* Bleeker (ex Verreaux)]

Diagnosis. Spines on head and belly erectile, those on back and sides fixed; fixed spines with 3 bases, erectile spines with 2 bases; spines long to medium; 9 C rays; 21 vertebrae; no tentacles; nostril in adult bifid; no spines wholly on dorsal surface of caudal peduncle, but large spines extend over the peduncle nearly to the caudal-fin base; no fins spotted; no large blotches on dorsal surface, but lateral bars present. Some additional osteological characters are given by Tyler (1980, ref. 4477).

The type species of *Dicotylichthys* is *D. punctulatus* Kaup (1855, ref. 2571). The sole species in this genus has erectile spines on the head and belly, but fixed ones on the back and sides. In contrast to the arrangement adopted here, some authors follow Fraser-Brunner (1943, ref. 1495) and include all diodontids that develop bifid nasal organs in *Dicotylichthys*.

This would place in the same genus such disparate species as *pilatus* with all fixed spines, *punctulatus* with a mixture of erectile and fixed spines, and *nicthemerus* with all erectile spines. However, *Dicotylichthys* is very similar to the monotypic *Lophodiodon* (see below). Bleeker's (1865, ref. 416) description of *Atopomycterus* (based on an unpublished manuscript by Verreaux held in MNHN) is brief, but fortunately the types of *A. diversispinus* Bleeker are extant (see below), thus clearly showing that *Atopomycterus* is a synonym of *Dicotylichthys*.

Dicotylichthys punctulatus Kaup, 1855

Dicotylichthys punctulatus Kaup, 1855: 230 (Cape of Good Hope, South Africa and Mauritius, but these localities are apparently incorrect, see below)*

Atopomycterus diversispinis Bleeker (ex Verreaux), 1865: 49 (Australia)*

Dicotylichthys myersi Ogilby, 1910: 18 (Moreton Bay, Queensland, Australia)*

* extant type

Based on over 50 lots from throughout the range, including all extant types. Kaup's (1855, ref. 2571) description is not detailed, but the extant specimens upon which he based his description are all of this distinctive species.

Although Bleeker's 1865 description of *Atopomycterus diversispinis* is brief, and not detailed, the syntypes are extant and readily identified as *D. punctulatus* Kaup (1855, ref. 2571; see Leis and Bauchot, 1984, ref. 12539).

Dicotylichthys myersi Ogilby (1910 ref. 3288) was said by Ogilby to differ from *D. punctulatus* by the relative size of the abdominal spines, but the syntypes are well within the range of relative spine size of *D. punctulatus*.

Distribution. South-eastern Australia.

From Moreton Bay, Qld to Bass Strait.

Kaup (1855, ref. 2571) reported that his type specimens came from the Cape of Good Hope and Mauritius. Subsequently, Günther (1870, ref. 1995) reported that the only specimen in BMNH identified as being from Mauritius was of questionable locality, and that the sole specimen from the Cape of Good Hope (which he identified as the 'type' of *D. punctulatus*) was "presented by Sir A. Smith". Smith was a medical doctor resident in Cape Town who procured many specimens from passing ships, and then provided them to the British Museum, where they were generally assumed to have originated in Cape Town (Bass et al., 1975, ref. 7409). Thus, there is good reason to question the locality data of Smith specimens (Bass et al., 1975, ref. 7409) if other evidence is inconsistent with them. Other than this BMNH specimen, I have been unable to find any institution (including RUSI) that has specimens of *D. punctulatus* from anywhere but Australia, where it is abundant within its range. Thus, I conclude that Sir A. Smith procured his specimen from a passing ship, not from the Cape of Good Hope, and that this species is endemic to south-eastern Australia.

Allomycterus McCulloch, 1921

Allomycterus McCulloch, 1921 (type species *Allomycterus jaculiferus* [non-Cuvier] McCulloch = *Allomycterus pilatus* Whitley)

Diagnosis. All spines fixed except 1 or 2 in P axil; spines with 3 bases except erectile ones; spines long or short; 9 C rays; no tentacles in adults; nostril in adult bifid; no spines wholly on dorsal surface of caudal peduncle, but large spines that extend over the peduncle nearly to the caudal-fin base; no fins spotted; no large blotches on dorsal surface, but lateral bars may be present.

The type species of this genus is *A. jaculiferus* (non-Cuvier) McCulloch. McCulloch (1921, ref. 2945), apparently following Günther's (1870, ref. 1995) concept of *jaculiferus*, provided an excellent illustration of the species he was proposing as the type of his new genus. However, it was not *D. jaculiferus* of Cuvier (1818, ref. 18059). Whitley (1931, ref. 4673) realized this, and also realized that McCulloch's fish was undescribed. Whitley therefore described as new *Allomycterus pilatus*, and designated as his holotype the specimen illustrated and described by McCulloch (1921). Not surprisingly, this has caused some confusion.

Allomycterus pilatus Whitley, 1931

Allomycterus jaculiferus (non-Cuvier) McCulloch, 1921: 141, pl. 23 (fig. 2) (New South Wales, Australia)

Allomycterus pilatus Whitley, 1931: 125 (NSW, Australia)*

Allomycterus whitleyi Phillipps, 1932: 13, fig. 5 (New Zealand)*

*extant type

Based on 38 lots from throughout the range, including the extant types. Confusion over the specific name of this species is dealt with under the genus. There seem to be two forms of this species, one with long, blade-like spines (*A. whitleyi* form), and another with short, compressed spines. Both forms occur off the Australian mainland, but I have seen only the long-spine form from New Zealand, and the specimens with the longest spines seem to be from New Zealand. These differences are not obviously connected with sexual dimorphism. Therefore, there may be two species of *Allomycterus*, and a genetic study would be useful in clarifying the situation. In addition, Kuiter (1993, ref. 23929) illustrates two colour morphs among south-eastern Australian specimens of *A. pilatus*, referring to deep-water and shallow-water forms. The basis for the colour differences is unclear and should be investigated. References to *Allomycterus jaculiferus* from New Zealand are based on *A. pilatus* (see discussion under *Allomycterus*).

Whitley's (1931, ref. 4673) description and McCulloch's (1921, ref. 2945) illustration are clear, and could apply to no other species. In addition, the holotype is extant.

Phillipps' (1932, ref. 16393) *A. whitleyi* constitutes the long-spined form from New Zealand, and although both holotype and paratype are stuffed and distorted, they appear to differ from *A. pilatus* only in the length and shape of the spines. Phillipps' description contains two spellings of the specific name: two as *whitleyi* and one as *whiteleyi*. Given the correct spelling of Gilbert Whitley's name (to whom the patronym refers), "*whiteley*" is clearly a typographical error even though it appears before the two uses of *whitleyi* within Phillips' article.

Distribution. Southern Australia and New Zealand.

Rottnest I., WA, to Botany Bay, NSW, including Tas.; Tasman Sea seamounts and ridges; and New Zealand.

Lophodiodon Fraser-Brunner, 1943

Lophodiodon Fraser-Brunner (type species *Diodon calori* Bianconi)

Diagnosis. Spines on head and belly erectile, those on back and sides fixed; fixed spines with 3 bases, erectile spines with 2 bases; spines short to medium; anteriorly-pointing spines on snout; 9 C rays; a small supraorbital tentacle in adults; nostril in adult a short tube with 2 openings; no spines wholly on dorsal surface of caudal peduncle, but large spines extend over the peduncle nearly to the caudal-fin base; no fins spotted; no large blotches on dorsal surface, but bars present laterally.

The type species of this genus is *D. calori* Bianconi (1854, ref. 17949). The sole species in this genus has most spines on head and belly erectile, and those on back and sides fixed. This genus is similar in many ways to *Dicotylichthys*, differing primarily in that the nasal organ in *Dicotylichthys* is bifid, whereas in *Lophodiodon*, it is a hollow tube with two distinct nostrils. There is reason to expect that two genera may eventually be considered to be synonymous.

Lophodiodon calori (Bianconi, 1854)

Diodon calori Bianconi, 1854: 69 (Mozambique)
Lophodiodon nigropunctatus Smith, 1957: 222, fig. 4 (Port Alfred, South Africa)*
*extant type

Based on 13 specimens from most of the range, including the extant types. This species is widely distributed, but uncommon in collections.

Although the name *Diodon calori* dates from Bianconi, 1854 (ref. 17949), the illustration of *Diodon calori* in Bianconi (1855, ref. 295) is diagnostic for this species, with its large number of short spines, four lateral bars and no dorsal blotches.

Lophodiodon nigropunctatus Smith (1957, ref. 12171) was based on juveniles (30–60 mm SL), and the apparent difference in colour pattern with *L. calori* can be attributed to this. The spination of Smith's specimens is diagnostic.

Distribution. Indo-Pacific.

The 13 specimens I have examined are all from east Africa and Seychelles, but the species is reliably reported from Oman, Bali, Timor, the Australian Northwest Shelf, the South China Sea and New Caledonia, and somewhat less reliably as the similar *D. punctulatus* from New Guinea by Tortonese (1964, ref. 9080) and Munro (1967, ref. 6844).

Diodon Linnaeus, 1758

This genus was revised by Leis (1978, ref. 5529) with additional information on nomenclature and types in Leis and Bauchot (1984, ref. 12539), and information contained there is not repeated. Only information on *Diodon* species described since 1978 and on noteworthy new distributional information is included here. Note that figs 9 and 17 of Leis (1978) were switched (see 1979 errata facing p. 956, US Fishery Bulletin 76[4]): fig. 9 labelled *Diodon hystrix* is actually *D. holocanthus* and fig. 17 labelled *Diodon holocanthus* is actually *D. hystrix*.

Diodon eydouxii Brisout de Barneville, 1846

Diodon bertolettii de Lema, de Lucena, Saenger and de Oliveira, 1979: 35–38, figs 18–19 (Brazil)*
**extant type*

Diodon bertolettii can readily be identified as a synonym of *D. eydouxii* Brisout de Barneville based on its semi-lunate fins, blue colour, fin-ray counts, and from the photographs provided by de Lema et al. (1979, ref. 8836).

Leis (1978, ref. 5529) examined specimens of *D. eydouxii* Brisout de Barneville (1846, ref. 296) from 19 scattered localities in all warm oceans. I have now seen an additional 31 lots. These plus four acceptable literature records extend the known distribution of this species.

Distribution. Pelagic, Atlantic, Indian and Pacific Oceans.

W Indian – Cape of Good Hope to Zanzibar

E Indian – only record is Andaman Sea

W Pacific – Indonesia to Okinawa

Central Pacific – from near Samoa to Hawaii

E Pacific – equator to 20°N plus a California record (Lea, 1998: from Los Angeles Harbour, but misidentified as *C. reticulatus* [Linnaeus]).

W Atlantic – 28°S to 37°N

E Atlantic – 30°W is eastern-most specimen examined, but there are apparently valid literature records from the Azores (Azevedo, 2004) and from Spain (Crespo et al., 1987).

Diodon holocanthus Linnaeus, 1758

Diodon paraholocanthus, Kotthaus, 1979: 39, fig. 492 (Bab-el-Mandeb, southern Red Sea)*
*extant type

Kotthaus (1979, ref. 8818) confused *Diodon liturosus* Shaw with *Diodon holocanthus* Linnaeus, as is obvious from his description and photograph (his fig. 491) of what he called *D. holocanthus*. Then, having encountered the true *D. holocanthus* in the north-western Indian Ocean, he described it as a new species, *D. paraholocanthus*. The description and photo (his fig. 492) of the holotype are entirely consistent with *D. holocanthus* Linnaeus.

Leis (1978) examined 141 specimens of *D. holocanthus* Linnaeus (1758, ref. 2787) from all warm oceans. I have now seen more than 100 additional lots that extend the known distribution of the species (see below). It is noteworthy that there are still no records of *D. holocanthus* from the Pacific Plate other than those reported by Leis (1978): Hawaii, Easter and Pitcarin Is. Reference in Robertson et al. (2004) and Mundy (2005, ref. 28379) to *D. holocanthus* occurring in the Line Is. is incorrect (B.C. Mundy, personal communication).

Distribution. Circumtropical in Atlantic, Indian and Pacific Oceans (except only peripherally on Pacific Plate).

W Indian – from Cape of Good Hope, South Africa to Oman and Red Sea, Sri Lanka, Mascarenes, and Seychelles.

E Indian – Andaman Sea to Australia

W Pacific – west of Pacific Plate: Japan to New Caledonia and Elizabeth and Middleton Reefs, Tasman Sea.

In Australia, south to Ulladulla, NSW (36°S) off east coast, and to Freemantle, WA (32°S) off west coast.

Central Pacific – Hawaii, Easter and Pitcarin Is. only.

E Pacific – southern California to Colombia

W Atlantic – Hudson Canyon (off New Jersey) to Argentina.

E Atlantic – Liberia and Nigeria to northern Angola .

Diodon hystrix Linnaeus, 1758

Leis (1978) examined 43 specimens of *Diodon hystrix* Linnaeus (1758, ref. 2787) from all warm oceans. I have now seen an additional 80 lots that extend the documented distribution of the species (see below).

Distribution. Circumtropical in Atlantic, Indian and Pacific Oceans

W Indian Ocean – throughout the area from South Africa (Tsitsikamma Coastal National Park) to the Red Sea, Sri Lanka, and all major island groups.

Australia – south to Elizabeth and Middleton Reefs, Lord Howe I., and northern NSW (29°S) off the east coast, and Rowley Shoals on west coast.

W Pacific – New Caledonia and Kermadecs to Rotuma, Pitcarin I., Hawaii and southern Japan.

E Pacific – Mexico to Chile

W Atlantic – 36°N to ca 20°S

Central Atlantic – Ascension and St Helena

E Atlantic – only 1 confirmed record at Fernando Po

Diodon liturosus Shaw, 1804

Leis, 1978 examined 30 specimens of *Diodon liturosus* Shaw (1804, ref. 4015) primarily from the western Pacific. I have now seen an additional 45 lots that extend the documented distribution of the species (see below).

Distribution. Indo-west Pacific

W Indian Ocean – South Africa (Algoa Bay) to Oman and southern Red Sea, Mascarenes, Seychelles, Laccadives and Maldives.

E Indian Ocean – Phuket, Thailand to Ningaloo Reef, WA

W Pacific – from Maizuru, Japan to northern NSW, Australia to New Caledonia to Society and Marshall Is.

Diodon nicthemerus Cuvier, 1818

Leis (1978) examined nine specimens of *Diodon nicthemerus* Cuvier (1818, ref. 18059), all from southern Australia. Museums in Australia contain large numbers of this species, and its distribution is confirmed as being confined to the waters of southern Australia. I have seen specimens from an area ranging from Houtman Abrolhos Is., WA (28°S), to Nadgee, NSW (37°S), although Kuiter (1993) reports *D. nicthemerus* as far north as Seal Rocks (32°S). This is the most restricted distribution of any species of *Diodon*.

Key to genera and species of the family Diodontidae

NB: in juveniles relative spine length and body colour generally differ from those of adults

1. All body spines erectile and 2-rooted (except a few around gill opening or dorsal-fin base) .... *Diodon* 10
— All or most body spines of back and sides fixed in an erect position and 3-rooted 2

Non-*Diodon*

2. Indian and Pacific in distribution 3
— Atlantic in distribution ....
(NB: 1 Indo-Pacific species, *Cyclichthys spilostylus,* has penetrated the eastern Mediterranean Sea through the Suez Canal 14

Indo-Pacific non-*Diodon*

3. Spines on top of head and on belly erectile 4
— Spines on top of head and on belly fixed in an erect position 5
4. 2 to 4 spines in the 1st row on the snout point toward the mouth when not erect; no small, black spots scattered more or less uniformly over head and trunk .... *Lophodiodon calori* (Indo-west Pacific)
— All erectile spines point toward tail when depressed; small, black spots scattered more or less uniformly over head and trunk .... *Dicotylichthys punctulatus* (south-east Australia)
5. A small spine or 2 wholly on the dorsal surface of the caudal peduncle; normally 10 caudal rays; nasal organ of adults an open ridged cup; adults with fins spotted .... *Chilomycterus reticulatus* (circumtropical)
— No spines wholly on the caudal peduncle; normally 9 caudal rays; nasal organ of adults a short tube with either 2 openings or split at the end (not an open cup); no spots on fins of adults 6
6. A set of 4 long fixed spines with their bases near the dorsal and anal-fin bases – their pointed ends extend over the caudal peduncle; a few spines in P axil erectile 7
— No especially long spines around dorsal and anal fin bases; spines in P axil fixed 8
7. Very long spines (longer than rays of pectoral fin) in pectoral-fin axil; 3–4 black spots (< eye) on sides of head and trunk, none on back .... *Tragulichthys jaculiferus* (tropical Australia)
— Spines of pectoral-fin axil not particularly elongate; some eye-size dark spots on back generally associated with spine bases .... *Allomycterus pilatus* (temperate Australia, Tasman Sea and New Zealand)
8. Few black spots on body, those present at base of spines dorsally and dorso-laterally; D, A and C fins with dusky distal margin; only 2 spines over eye; 2 spines between nostrils, 1 immediately adjacent to each nostril .... *Cyclichthys hardenbergi* (tropical Australia, southern New Guinea)
— Black spots in clusters dorsally and laterally, or associated with spine bases laterally and ventrally; D, A and C fins either clean or with faint, parallel bands; 3 spines over eye; only 1 spine between nostrils, located medially 9

9. Spines few, 4 dorsally between pectoral-fin bases, 8 or 9 anterior to dorsal-fin base; a short, moveable spine near corner of mouth; all spines on top of head with 3 bases; black spots in clusters dorsally and dorsolaterally .... *Cyclichthys orbicularis* (Indo-west Pacific)
— Spines more numerous, 5 or 6 dorsally between pectoral-fin bases, 11 or 12 anterior to dorsal-fin base; no moveable spines; some spines on top of head with 4 bases; black spots at base of spines laterally and ventrally .... *Cyclichthys spilostylus* (Indo-Pacific)

Diodon

10. None of spines wholly on caudal peduncle; body with several large, dark dorsal or lateral blotches; no small, dark spots on fins 11
— One or more small spines wholly on the dorsal surface of caudal peduncle; body without large dorsal blotches; all fins (anal sometimes excepted) heavily spotted 13
11. Temperate Australian waters only; no small, fixed, tri-base spine immediately above gill opening; no small, flat spines on the anterior border of the depression surrounding the gill opening; 11 or fewer spines from lower jaw to anus; adult colour pattern dominated by 4, large, lateral bars, dorsum uniformly dark .... *Diodon nicthemerus* (southern Australia).
— Tropical waters, with strays into warm temperate water; 1 or 2 small, fixed tri-base spines above gill opening; 3 or 4 small, flat spines forming the anterior border of depression surrounding the gill opening; 12 or more spines from lower jaw and anus; adult colour pattern dominated by several large, dorsal blotches 12
12. Frontal spines obviously much shorter than spines immediately behind pectoral fin; small downward-pointing spine below anterior margin of eye; 17–22 spines from lower jaw to anus; large dorsal blotches with distinct pale border; blotch below eye not continuing over top of head .... *Diodon liturosus* (Indo-Pacific)
— Frontal spines slightly shorter to much longer than spines immediately behind the pectoral-fin base; small downward-pointing spine below anterior margin of eye absent (Indo-Pacific) or present (most Atlantic specimens); 12–15 spines from lower jaw to anus; dorsal blotches without distinct pale border; blotch below eye continues over interorbital in Indo-Pacific specimens .... *Diodon holocanthus* (circumtropical)
13. Pectoral-fin rays 19–22; anal-fin rays 16–18; dorsal and anal fins somewhat pointed to semilunate in adults; relatively streamlined, head width of adults 3.3–4.0 in standard length; 10–14 spines from lower jaw to anus; a wholly pelagic species coloured dark-blue dorsally .... *Diodon eydouxii* (circumtropical)
— Pectoral-fin rays 22–25 (rarely 21); anal-fin rays 14–16; dorsal and anal fins rounded in adults; relatively robust, head width of adults 2.4–3.3 in standard length; 14–19 spines from lower jaw to anus; juveniles (up to 20 cm) pelagic and coloured blue dorsally, adults demersal and coloured tan to brown .... *Diodon hystrix* (circumtropical)

Atlantic non-*Diodon*

14. 1 or 2 small spines wholly on the dorsal surface of the caudal peduncle; normally 10 caudal-fin rays; nasal organ of adults, an open, ridged cup; adults with fins spotted; on top of head some spines with 4 roots .... *Chilomycterus reticulatus* (circumtropical)
— No spines wholly on the caudal peduncle; normally 9 caudal-fin rays; nasal organ of adults, a short hollow tube with 2 openings; fins of adults usually without spots; all spines with 3 roots .... "Atlantic *Chilomycterus*" 15
15. A large (ca. = eye diameter) tentacle above eye; colour pattern dominated by large dorsal blotches and with small spots scattered on back and sides, on fins only basally, except on most or all of caudal fin from 10–15 cm standard length, and on other fins from 20 cm .... *Chilomycterus antennatus* (central-west Atlantic)
— Tentacles above eyes absent or small; no small spots on fins or on back and sides; dorsal and lateral dark blotches present 16
16. Network of hexagonal to circular black lines on back and sides in adults .... *Chilomycterus antillarum* (central-west Atlantic)
— Black lines on back and sides absent in adults, or if present, wavy or approximately parallel – not intersecting to form rings or polygons 17
17. Extensive series of dark-brown to black parallel lines densely covering back and sides in adults .... *Chilomycterus schoepfii* (western North Atlantic)
— No black lines on back; dorsal background dark with diffuse lighter spots .... *Chilomycterus spinosus* 18
18. No black lines on sides of head or trunk; South American in distribution .... *Chilomycterus spinosus spinosus* (east coast South America)
— Irregular, approximately parallel black lines on sides of head and trunk; eastern Atlantic in distribution .... *Chilomycterus spinosus mauretanicus* (west coast Africa)

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A new species of *Zenopsis* (Zeiformes: Zeidae) from the South China Sea, East China Sea and off Western Australia

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Abstract

Nakabo T., Bray D.J. and Yamada U. 2006. A new species of *Zenopsis* (Zeiformes: Zeidae) from the South China Sea, East China Sea and off Western Australia. *Memoirs of Museum Victoria* 63(1): 91–96.

Zenopsis stabilispinosa sp. nov. is described from the South China Sea, East China Sea and off Western Australia. It differs from other species of *Zenopsis* in having the third anal-fin spine fused to its pterygiophore, seven dorsal-fin spines, a short pelvic fin in adults, and 32 (13+19) vertebrae. A key to the species of *Zenopsis* is provided.

Keywords Zeidae, *Zenopsis*, new species, South China Sea, Western Australia

Introduction

The species of *Zenopsis* are characterized by having a deep strongly compressed silvery body, scales absent from the body except along the lateral line, concave dorsal head profile, enlarged bucklers along most of the spinous dorsal-fin base and along the soft dorsal- and anal-fin bases, three anal-fin spines, six pelvic-fin elements, and narrow infraorbitals. Three species of *Zenopsis* are currently recognized: *Z. nebulosa* Temminck and Schlegel, 1845, *Z. conchifer* Lowe, 1852 and *Z. oblonga* Parin, 1989. During surveys of demersal fishes in the South China Sea and off Western Australia, ten specimens of *Zenopsis* which differ significantly from these three *Zenopsis* species were collected. They are described herein as a new species.

Material and methods

Museum abbreviations follow Leviton et al., 1985, with the exception of the following: SNFR – Seikai National Fisheries Research Institute. Counts and measurements (Tables 1 and 2) follow Nakabo, 2002a. Vertebral numbers and anal-fin pterygiophore configurations were obtained from radiographs.

Zenopsis stabilispinosa sp. nov.

Figures 1–3A, 4, Tables 1–2

Zenopsis sp. nov. Bray, 1983: 106, fig. 16; *Zenopsis* sp. (off Western Australia): Williams et al., 1996: 150 (off Western Australia), Tyler et al., 2003: 2 (South China Sea and off Western Australia).

Material examined. Holotype. FAKU 64803 (307.2 mm SL), South China Sea, 19°45.0'N, 114°04.0'E, 457–767 m, JAMARC (Japan Marine Fishery Resource Research Center), 20 Jun, 1991.

Paratypes. FAKU 64804 (410.1 mm SL), South China Sea, 19°47.0'N, 114°05.0'E, 465–505 m, JAMARC, 21 Jun 1991; AMS I.22826-004 (206.1 mm SL), North-west Shelf, Western Australia 210 km NW of Port Hedland, 18°44'S, 117°02'E, 396–406 m, J. R. Paxton, CSIRO RV *Soela*, 13 Apr, 1982; AMS I.31146-001 (2, 100.2–103.3 mm SL), off North-west Cape, Western Australia, 21°37.9'S, 113°59.3'E, 209–215 m, J. R. Paxton, CSIRO RV *Southern Surveyor*, 24 Jan, 1991; AMS I.31147-002 (3, 80.4–104.5 mm SL), off North-west Cape, Western Australia, 21°44.5'S, 113°52.5'E, 290–320 m, J. R. Paxton, CSIRO RV *Southern Surveyor*, 24 Jan, 1991; ASIZ P.0057609, off Donggang, Pintung, Taiwan, 22 28 12 N, 120 25 48 E, K. T. Shao, 8 Oct, 1985; ASIZ P.0060011, fish market, Dahsi, Ylian, Taiwan, 24 57 00 N, 121 52 48 E, B. H. Gao, 10 Aug, 1997.

Diagnosis. *Zenopsis stabilispinosa* differs from its congeners in the following combination of characters: dorsal fin with 7 spines; anal fin with first 2 spines movable and 3rd spine immovable, fused with its pterygiophore; pelvic fin short, 1.69–1.79 in HL, in adult specimens greater than 300 mm SL; bony bucklers along bases of spinous and soft-rayed portions of dorsal fin 3–4+5–6; bucklers along ventral body margin anterior to pelvic fin and between pelvic- and anal-fin origins, and along anal-fin base 5–6+6–7+5–6 and vertebrae 32 (13 abdominal + 19 caudal).

Description. (values for paratypes in parentheses if different from holotype). Dorsal fin VII, 26; anal fin III, 23; pectoral fin rays 12 (12–13); gill rakers 3+9 (3–4+8–10); dorsal bucklers

Figure 1. *Zenopsis stabilispinosa* sp. nov. Holotype, FAKU 64803 (307.2 mm SL).

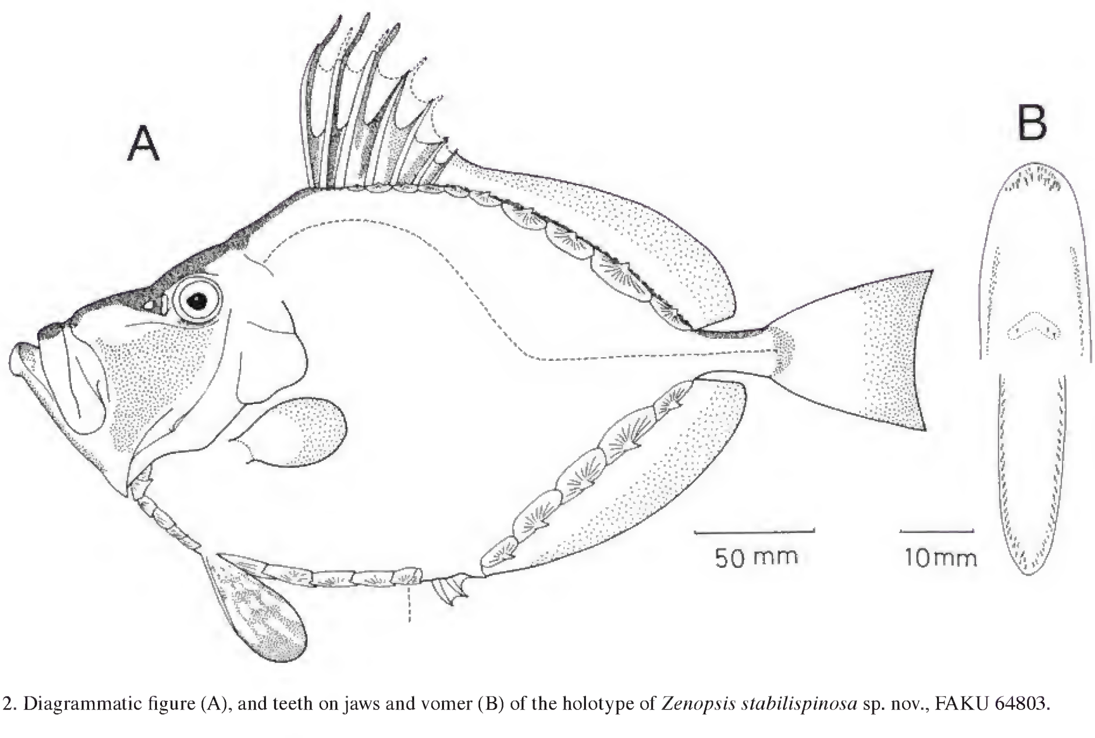

Figure 2. Diagrammatic figure (A), and teeth on jaws and vomer (B) of the holotype of *Zenopsis stabilispinosa* sp. nov., FAKU 64803.

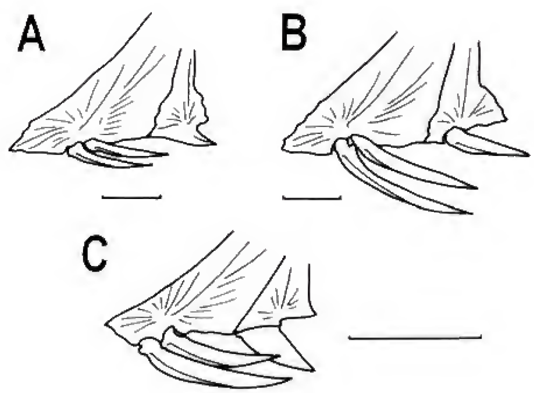

Figure 3. Diagrammatic figures of anal-fin pterygiophores and spines of 3 species of *Zenopsis*: A, *Z. stabilispinosa*, holotype, FAKU 64803 (307.2 mm SL); B, *Z. nebulosa*, FAKU 64805 (379 mm SL); C, *Z. conchifer*, RUSI 14070 (135.5 mm SL). Scales indicate 10 mm.

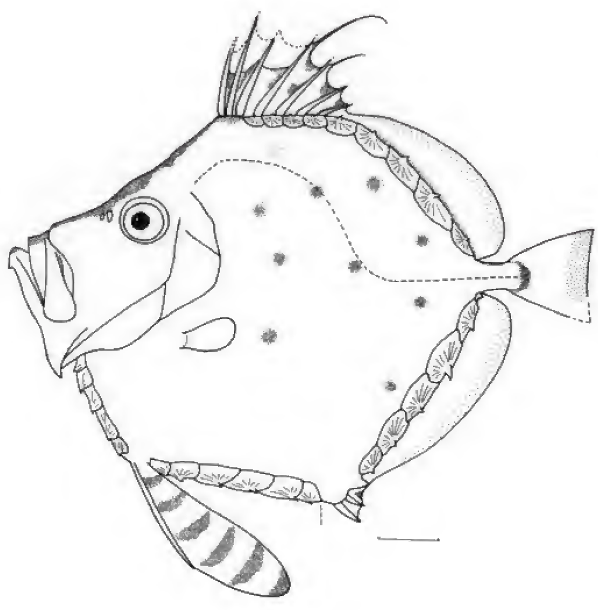

Figure 4. Diagrammatic figure of a juvenile of *Zenopsis stabilispinosa*, AMS I.31147-002 (80.4 mm SL), paratype.

4+6 (3–4+5–6); ventral bucklers 6+6+5 (5–6+6–7+5–6); vertebrae 13+19. Body deep, strongly compressed, scales absent except along lateral line. Head strongly compressed, dorsal profile slightly concave. Nostrils located just before eye; anterior nostril rounded, posterior nostril oblong. Mouth large, strongly oblique; upper jaw extremely protrusible. Teeth in upper jaw in 2 separate bands; anterior band with 3 irregular rows of small caniform teeth, inner teeth larger than outer ones; posterior band very narrow, long with minute caniform teeth. Lower jaw with 2 irregular rows of small caniform teeth; 2 teeth on inner row of anteriormost part larger than other teeth. Vomer with 1 small caniform tooth on right side, 2 small caniform teeth on left side (with 0–3 caniform teeth on right side, 0–7 on left side; mode 2 on both sides). Palatine toothless. Tongue thick, long and pointed. Gill-rakers on 1st gill-arch short. Pseudobranchiae well-developed. Lateral line arched below spinous portion of dorsal fin, following midline axis of body from below anterior one-third of soft dorsal fin, to caudal-fin base. Caudal peduncle moderately long, narrow. Dorsal-fin origin vertically to almost vertically above posterior tip of operculum; anterior dorsal-fin spines long with filamentous membranes; soft dorsal fin convex, rays increasing in length to 18th ray. Anal fin origin near vertical through notch between spinous and soft-rayed portions of dorsal fin; 1st and 2nd anal-fin spines small, movable, 3rd spine immovable (fused with pterygiophore); 2nd and 3rd anal-fin spines and 1st anal-fin ray connected by membrane; soft anal fin convex, rays increasing in length to about 16th ray. Pectoral fin rounded, reaching to vertical below bases of 4th and 5th dorsal-fin spines. Pelvic fin relatively short, 1.69 in HL (1.79 in paratype 324.4 mm SL, but somewhat longer, 0.98–1.26 in HL, in juvenile paratypes 80.4–206.1 mm SL), origin anterior to vertical through pectoral-fin base, fin not reaching anus when depressed (extending to anus in paratypes less than 105 mm SL). Caudal fin slightly emarginate.

4 (3–4) bony bucklers along base of spinous dorsal fin and 6 (5–6) bony bucklers along soft dorsal-fin base; each buckler with a dorsal spine. 6 (5–6) bony bucklers anterior to pelvic-fin base. 6 (6–7) bony bucklers with posterior spine between origins of pelvic and anal fins. Bucklers absent from base of anal-fin spines. 6 (5–6) bony bucklers, each with a vertical spine, along base of soft anal fin.

Colour when fresh. Body silver (with many dark spots in juvenile paratypes less than 105 mm SL). Dorsal margin of head and body dark-brown from snout to caudal peduncle. Spinous dorsal fin with a transverse broad dark-brown band on membrane; soft dorsal fin dusky distally, white basally. Anal fin dusky distally, white basally. Pectoral fin pale basally, dusky distally, with a small dark-brown spot dorsally on fin base. Pelvic fin with 4 irregular black bands (6–7 dark bands in juvenile paratypes less than 105 mm SL). Caudal fin with dark semicircular mark on base and broad dark band on posterior margin.

Etymology. The specific name, *stabilispinosa*, refers to the fused anal-fin spine.

We recommend that the standard name for this species be the Fixed-spine Mirror Dory.

Table 1. Selected meristics for species of Zenopsis

	Z. stabilispinosa		*Z. nebulosa*	*Z. conchifer*	*Z. oblonga*
	Holotype	Paratypes			
No. specimens	1	9	6	8	
Dorsal fin	VII, 26	VII, 27	IX, 27	IX-X, 24–26	VIII-X, 27–29
Anal fin	III, 23	III, 23	III, 25–26	III, 25–26	III, 25–27
Pectoral fin	12	12–13	12–13	12	11–13
Pelvic fin	6	6	6	6	6
Gill rakers (upper + lower)	3 + 9	3–4 + 8–10	3–4 + 7–9	2–3 + 8–10	
Vertebrae (AV + CV)	32 (13 + 19)	32 (13 + 19)	35(13 + 22)	34–36(13 + 21–23)	36
Dorsal bony bucklers*	4 + 6	3–4 + 5–6	5–7 + 6–7	2–3 + 5	6–7 + 8–9
Ventral bony bucklers**	6 + 6 + 5	5–6 + 6–7 + 5–6	5–6 + 7–9 + 8–10	1–3 + 6–8 + 5–6	2–3 + 7–8 + 9–11

* along spinous and soft dorsal-fin bases
**anterior to pelvic fin + between pelvic fin and anal fin + along anal-fin base

Relationships. *Zenopsis stabilispinosa* differs from *Z. nebulosa, Z. conchifer* and *Z. oblonga* in having the first two anal-fin spines movable and a third fused to the pterygiophore (versus three movable anal-fin spines in the other three species; in some specimens of *Z. conchifer* the third anal-fin spine is more or less fixed, but is not fused with the pterygiophore, fig. 3C). As the movable third anal-fin spine is based on the second anal pterygiophore in the latter three species (fig. 3B), it is likely that the spine-like posterior process projecting from the third anal pterygiophore of *Z. stabilispinosa* represents the third anal-fin spine fused to its pterygiophore (fig. 3A). Fused anal-fin spines have previously been reported in two other zeiform families: family Parazenidae – *Cyttopsis rosea* Lowe, 1843, and family Cyttidae – *Cyttus novaezelandiae* Arthur, 1885 and *C. traversi* Hutton, 1872 (Bray, 1983, Heemstra, 1980, Tyler et al., 2003).

Zenopsis stabilispinosa also differs from its congeners in having seven dorsal-fin spines (versus eight to ten dorsal-fin spines), 19 caudal vertebrae (versus 22–23 caudal vertebrae) and a smaller pelvic fin, 1.69–1.79 in HL in specimens greater than 300 mm SL of *Z. stabilispinosa* (versus almost the same as or more than HL in other species).

Zenopsis stabilispinosa is similar to *Z. nebulosa* in having five to six ventral bony bucklers anterior to the pelvic fin (versus two to three bucklers in *Z. conchifer* and *Z. oblonga*). *Zenopsis stabilispinosa* and *Z. conchifer* resemble *Z. conchifer* in lacking ventral bony bucklers along the anal-fin spines (versus having one to two ventral bony bucklers in *Z. nebulosa* and *Z. oblonga*).

Remarks. Opinion differs regarding whether the first pelvic-fin element in *Zenopsis* is a spine or a ray. Here, we follow Tyler et al., 2003 in regarding the first pelvic-fin element as a ray because it is completely divided throughout its entire length, despite being neither segmented nor branched.

Key to the species of *Zenopsis*

1a) Dorsal-fin spines 7; 3rd anal-fin spine immovable (fused to pterygiophore); caudal vertebrae 19 .... *Z. stabilispinosa* sp. nov.
1b) Dorsal-fin spines 8–10; 3rd anal-fin spine movable (not fused to pterygiophore); caudal vertebrae 21–23 2
2a) Bony bucklers along spinous portion of dorsal-fin base 1–3; bucklers absent from base of anal-fin spines .... *Z. conchifer*
2b) Bony bucklers along spinous dorsal-fin base 5–7; 1–2 bony bucklers along base of anal-fin spines 3
3a) Bony bucklers on ventral margin anterior to pelvic-fin base 5–6 .... *Z. nebulosa*
3b) Bony bucklers on ventral margin anterior to pelvic-fin base 2–3 .... *Z. oblonga*

Comparative material examined

Zenopsis conchifer: RUSI (J. L. B. Smith Institute of Ichthyology) 13801, (3, 65.6–135.8 mm SL), Kenya, Malindi, 3°04'S, 40°25'E, P. C. Heemstra, 17 Nov 1980; RUSI 14070 (5, 84.8–135.5 mm SL), Kenya, Ras Ngomeni, 2°50'S, 40°34'E, P. C. Heemstra, 12 Dec 1980. *Zenopsis nebulosa*: FAKU 64805, SNFR 1068 (313–381 mm SL), East China Sea, 30°49'9N, 128°56'2E, 355–379 m, SNFR, 26 Oct 1991; SNFR 336, 1610, 1611, (86–152 mm SL), East China Sea, 32°12'7N, 127°34'7E, 117 m, SNFR, 14 Oct 1982; SNFR 1066 (232 mm SL), East China Sea, 29°14'7N, 127°34'7E, 408 m, SNFR, 2 Oct 1989. *Zenopsis oblonga*: USNM 285048, E. Pacific, Nazca Ridge, 25°39'S, 85°37'W, 210 m (paratype); USNM 353898, SE Pacific, Sala-Y-Gomez Ridge, 25°02S, 97.48°W, 330 m, N. Parin et al., 3 May 1987.

Table 2. Measurements of *Zenopsis stabilispinosa* sp. nov. Measurements are in mm; proportions (% SL) in parentheses.

	Holotype		Paratypes																	
Catalog no.	FAKU 64803		FAKU 64804		AMS I.22826-004		AMS I.31146-001		AMS I.31146-001		AMS I.31147-002		AMS I.31147-002		AMS I.31147-002		ASIZ P.0060011		ASIZ P.0057609	
		% SL		% SL		% SL		% SL		% SL		% SL		% SL		% SL		% SL		% SL
Total length	381.1		410.1		259.1		124.1		125.8		132.5		120.2		102.4		446.1		105.8	
Standard length (SL)	307.2		324.4		206.1		100.2		103.3		104.5		95.9		80.4		356.8		82.2	
Head length (HL)	110.9	36.1	123.8	38.2	75.1	36.4	41.6	41.5	39.7	38.4	41.1	39.3	38.5	40.1	32.1	39.9	130.8	36.7	33.7	41.1
Body depth	171.4	55.8	179.0	55.2	125.7	61.0	71.7	71.6	75.8	73.5	76.2	72.9	69.6	72.6	64.0	79.6	194.4	54.5	63.5	77.3
Body width	25.6	8.3	26.3	8.3	16.4	8.0	9.0	9.0	9.4	9.1	8.6	8.2	8.5	8.9	6.4	8.0	28.3	7.9	8.0	9.7
Predorsal length	119.9	39.0	133.8	41.2	88.9	43.1	45.1	45.0	44.8	43.4	48.3	46.2	41.7	43.5	35.8	44.5	134.6	37.7	17.5	21.3
Snout length	57.6	18.8	62.1	19.1	40.4	19.6	20.5	20.5	20.5	19.8	21.4	20.5	18.8	19.6	15.4	19.2	68.9	19.3	15.9	19.3
Eye diameter	21.7	7.1	23.6	7.3	17.3	8.4	9.8	9.8	9.0	8.7	10.0	9.6	9.3	97.0	8.1	10.1	26.2	7.3	8.7	10.6
Orbit diameter	23.4	7.6	25.7	7.9	17.7	8.6	10.5	10.5	9.9	9.6	10.4	10.0	9.6	20.0	8.6	10.7	27.8	7.8	9.3	11.3
Postorbital length	43.5	14.2	49.3	15.2	23.3	11.3	12.4	12.4	11.6	11.2	14.8	14.2	11.4	11.9	10.0	12.4	35.0	9.8	10.6	12.9
Interorbital length	17.7	5.6	17.6	5.4	14.2	6.9	7.8	7.8	8.0	7.7	8.3	7.9	7.4	7.7	6.4	8.0	20.4	5.7	6.8	8.3
Preanal length	195.5	63.5	218.8	67.4	138.1	67.0	75.6	75.0	78.5	76.0	77.5	74.2	73.4	76.5	65.0	80.8	225.9	63.3	55.7	67.8
Caudal peduncle depth	16.8	5.5	14.8	4.6	9.6	4.7	5.1	75.4	5.7	5.5	5.4	5.2	5.2	5.4	4.8	6.0	15.4	4.3	4.4	5.4
Caudal peduncle length	33.1	10.8	36.0	11.1	19.2	9.3	10.0	10.0	9.1	8.8	9.4	9.0	8.7	9.1	8.3	10.3	138.7	38.9	6.3	7.7
Pectoral-fin length	43.2	14.1	45.7	14.1	31.2	15.1	12.6	12.6	15.4	14.9	75.0	71.6	14.4	15.0	10.7	13.3	52.4	14.7	13.0	15.8
Pelvic-fin length	65.8	21.4	69.0	21.3	59.5	28.9	36.9	36.8	37.8	36.6	37.2	35.6	36.8	38.4	32.7	40.7	73.5	20.6	33.1	40.3
Caudal-fin length	66.6	21.7	70.0	21.6	47.9	23.2	20.2	20.2	23.2	22.5	23.3	22.3	23.4	24.4	18.8	23.4	73.3	20.5	21.5	26.2
1st dorsal-spine length	54.2	17.6	-	-	-	23.9	-	-	-	-	-	-	-	-	-	-	71.9	20.2	-	-
2nd dorsal-spine length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3rd dorsal-spine length	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4th dorsal-spine length	-	-	-	-	-	-	18.0	18.0	-	-	-	-	16.4	17.1	-	-	-	-	-	-
5th dorsal-spine length	39.9	13.0	40.7	12.5	20.4	9.9	11.8	11.8	17.5	16.9	-	-	13.0	13.6	15.2	18.9	-	-	16.9	20.6
6th dorsal-spine length	24.1	7.8	22.0	6.8	14.0	6.8	9.2	9.2	-	-	12.8	12.2	7.7	8.0	11.5	14.3	31.3	8.8	-	-
7th dorsal-spine length	16.4	5.3	15.8	4.9	4.8	2.3	5.6	5.6	5.1	4.9	7.9	7.6	7.5	7.8	5.8	7.2	16.3	4.5	-	-
Longest dorsal-ray length	33.2	10.8	37.8	11.7	-	-	12.3	12.3	12.4	12.0	14.5	13.9	13.4	14.0	10.8	13.4	39.0	10.9	13.0	15.8
1st anal-spine length	19.1	4.6	13.9	4.3	9.3	4.5	8.6	8.6	8.0	7.7	-	-	7.8	8.1	7.6	9.4	17.0	4.8	7.5	9.1
2nd anal-spine length	13.1	4.3	12.5	3.9	7.1	3.4	6.8	6.8	4.4	4.3	8.9	8.5	4.4	4.6	6.2	7.7	13.3	3.7	4.9	6.0
3rd anal-spine length	8.1	2.6	10.4	3.2	8.3	4.0	4.3	4.3	5.6	5.4	5.9	5.6	5.2	5.4	4.7	5.8	12.7	3.6	3.5	4.3
Longest anal-ray length	34.6	11.3	37.3	11.5	17.3	8.4	10.9	10.9	11.5	11.1	12.1	11.6	12.5	13.0	10.0	12.4	38.3	10.7	11.4	13.9

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Australian trevallies of the genus *Pseudocaranx* (Teleostei: Carangidae), with description of a new species from Western Australia

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Abstract

Smith-Vaniz W.F. and Jelks H.L. 2006. Australian trevallies of the genus *Pseudocaranx* (Teleostei: Carangidae), with description of a new species from Western Australia. *Memoirs of Museum Victoria* 63(1): 97–106.

Pseudocaranx dinjerra sp. nov. is described from Western Australia. It differs from the Australian endemic *Pseudocaranx wrighti* in having the posterior margin of the upper jaw nearly vertical, lachrymal without scales, 19–21 versus 24–28 lower gill rakers and 53–66 versus 37–48 scales in the curved part of the lateral line. The new species is distinguished from Australian populations of *P. georgianus* and "*dentex*" primarily by having a different combination of meristic values including 14 versus 15 caudal vertebra, 19–21 versus 21–24 segmented anal-fin rays and 58–75 versus 72–95 total lateral-line scales. Diagnoses are given for *P. wrighti* and *P. georgianus*, and specimens from Queensland and Lord Howe Island are discussed and provisionally identified as *P. dentex*.

Keywords Carangidae, *Pseudocaranx*, new species, Western Australia, antitropical distribution

Introduction

Carangid fishes of the genus *Pseudocaranx* Bleeker, 1863 occur in subtropical and warm temperate regions of the world's oceans with single species, *P. dentex* Bloch and Schneider, 1801 and *P. chilensis* Guichenot, 1848, present in the Atlantic and eastern Pacific oceans, respectively. In the Indo-west Pacific, the genus consists of a complex of species for which 13 names have been proposed, eight based on fish from Australia or New Zealand. Except for the Australian endemic *Pseudocaranx wrighti* Whitley, all of these species are very similar externally and their scientific names have been inconsistently used and frequently misapplied. Determining the taxonomic status of some disjunct and sympatric populations (e.g., Yamaoka et al., 1991; Masuda et al., 1995) will probably require both morphological and molecular data. Unraveling the evolutionary history of these carangids is also challenging because they have antitropical distributions that are not easily explained (Briggs, 1987) and is confounded by the Miocene origins of Indo-Pacific coral reef fish biodiversity, which predates Pleistocene glaciations (Read et al., 2006).

In the course of acquiring vertebral counts from a large series of *Pseudocaranx* from many localities, we observed that all specimens from both sides of the Atlantic Ocean have 15 caudal vertebrae and those from many relatively isolated locations in the Indo-Pacific consistently have either 14 or 15 caudal vertebrae. The discovery that *Pseudocaranx* species from Western Australia include taxa with either 14 or 15 caudal vertebrae and non-overlapping geographic distributions resulted in a re-evaluation of the taxonomic status of species that Paxton et al., 1989 and Smith-Vaniz, 1999 had referred to collectively as *P. dentex*. These fishes are herein recognized as *P. georgianus* Cuvier and a new species *P. dinjerra*, respectively. Identification of the *Pseudocaranx* species that occurs off southern Queensland and at Lord Howe Island is unresolved and is here tentatively referred to as *Pseudocaranx* sp. "*dentex*".

In their review of *P. georgianus* from temperate Australasian waters, James and Stephenson, 1974 concluded that only one species was represented but observed that some collections from southern Australia contained two groups of fish each having either 24 or 25 total vertebrae and different proportions (body depth, snout/head lengths and eye diameter). Re-examination of most of the specimens available for their study revealed that all of those with 24 vertebrae are *P. wrighti* (species not mentioned by them) and that those with 25 vertebrae are *P. georgianus*. Although James and Stephenson, 1974 failed to appreciate a number of additional characters that distinguish these two species, they correctly reported that specimens from Norfolk and Kermadec (Raoul) Is. consistently have 14 caudal (24 total) vertebrae, as do most of those from North Cape, New Zealand. Determination of the taxonomic status of these extralimital fish is beyond the scope of the present study; however, they definitely are neither *P. dinjerra* nor *P. wrighti*.

Material and methods

Museum abbreviations follow Leviton et al., 1985. In the material examined sections, specimen sizes are given as mm fork length (FL) and cleared and stained specimens are indicated as "C&S"; parenthetical expressions present number of specimens, if more than one, followed by size range. Localities are abbreviated and listed by major geographic areas. Scutes are defined as scales that have a raised horizontal ridge on their posterior margin with a small to moderate projecting spine ending in a point not exceeding a 120° angle. All scutes are counted, including those on the caudal-fin base. Pectoral-ray counts do not include the dorsal-most spine-like element. Gill-raker counts are from the first gill arch (usually on the right side), with the raker at the angle included in the lower-limb count; rudimentary gill rakers are defined as tubercles or short rakers with the diameter of their bases greater than their height. Measurements were analyzed using a sheared principal component analysis (PCA) following Rohlf and Bookstein, 1987. The following 22 point-to-point measurements were taken for the relatively few specimens ≥ 200 mm FL: fork length (FL) from tip of snout to tip of shortest median caudal-fin ray; snout to origin of first dorsal fin (D1O); snout to origin of second dorsal fin (D2O); snout to origin of pelvic fin (P2O); snout to origin of first anal-fin spine (A1O); length of dorsal-fin base; length of anal-fin base; D1O to P2O; D1O to origin of second dorsal fin (A2O); D2O to A2O; D2O to A1O; height of dorsal-fin lobe; height of anal-fin lobe; pelvic fin length; pectoral fin length; length of curved part of lateral line (CLL), measured as a cord (straight-line distance) of the arch extending from the upper edge of the opercle to its junction with the straight part; length of straight part of lateral line (SLL), measured from its junction with the curved part to its termination on the caudal-fin base (end of last scute); head length from tip of snout to posterior margin of the opercular flap; postorbital head length from posterior margin of orbit to posterior margin of the opercular flap; upper jaw length is from the snout tip to posterior end of maxilla; eye diameter is the horizontal diameter of the orbit.

Pseudocaranx Bleeker

Pseudocaranx Bleeker, 1863: 82.

Type species. *Scomber dentex* Bloch and Schneider, 1801, by subsequent designation of Fowler, 1936: 692.

Remarks. These fishes are presumed to comprise a monophyletic group, but the most appropriate generic classification for them is uncertain pending a well collaborated phylogeny of carangines. *Citula* Cuvier, 1816 (type species *Citula banksii* Risso, 1820 [= *P. dentex*] by subsequent monotypy) is an available senior synonym of *Pseudocaranx* (type species *Scomber dentex*) but this generic name has not been used for a nominal species of the group since Risso's description. In the interest of nomenclatural stability, the junior name should continue to be used pending a petition to the International Commission of Zoological Nomenclature to conserve the more familiar generic name. Other more recent synonyms of *Pseudocaranx* are *Longirostrum* Wakiya, 1924, *Usa* (as a subgenus of *Caranx*) Whitley, 1927, and *Usacaranx* Whitley, 1931. Within the Caranginae, *Pseudocaranx* and *Caranx equula* Temminck and Schlegel, 1844, which Kijima et al., 1986 and Gushiken, 1988 assign to the monotypic genus *Kaiwarinus* Suzuki, 1962, are exceptional in having very poorly developed inferior vertebral foramina, and may be a sister taxa.

Key to Australian species of *Pseudocaranx*

1. Posterior margin of upper jaw canted posteroventrally (fig. 1A); scales present on lachrymal; lower limb gill rakers 24–28; scales in curved portion of lateral line 37–48 (eastern Bass Strait to Exmouth Gulf, WA) .... *P. wrighti*
— Posterior margin of upper jaw nearly vertical (fig. 1B); no scales on lachrymal; lower limb gill rakers 19–23 (except 24–27 in fish from Qld and Lord Howe I., where *P. wrighti* does not occur); scales in curved portion of lateral line 53–80 2
2. Segmented anal-fin rays 19–21; total lateral-line scales 58–75, rarely >71; caudal vertebrae 14 (Houtman Abrolhos to North West Cape, WA) .... *P. dinjerra*
— Segmented anal-fin rays 21–24 (rarely 21); total lateral-line scales 72–95, rarely <74; caudal vertebrae 15 3
3. Lower limb and total gill rakers 19–23 and 28–35 (rarely 35), respectively (New Zealand and NSW to Lancelin I., WA) .... *P. georgianus*
— Lower limb and total gill rakers 24–27 and 36–41 (rarely 36), respectively (southern Qld, Australia and Lord Howe I.) .... *P.* sp. "*dentex*"

Pseudocaranx dinjerra sp. nov.

Figures 2, 3A, 4, 5; Tables 1–3

Pseudocaranx dentex (non Bloch and Schneider) in: Allen and Swainston, 1988: 74, fig. 447 (misident., in part, brief descr.) in: Hutchins, 1990: 270 (listed; Shark Bay); Hutchins, 1997: 247 (listed; Houtman Abrolhos).

Material examined. Holotype. NMV A.1962 (245), SW of Shark Bay, 25°28'S, 112°27'E, 25°19'S, 112°17'E; trawled in 131–139 m; M.F. Gomon; sta. MFG-71; 4 Mar 1981.

Paratypes. 38 specimens, 77–230 mm FL. ANSP 148695 (2, 221–230), off Cape Farquhar, 23°42'S, 113°01'E, 23°48'S, 112°58'E; trawled in 156–160 m; M/V TM 71; 13 Sep 1979. WAM P.22338 (217), Cape Cuvier, 24°13'S, 113°23'E; J. Penn; 29 Jul 1972. ANSP 148696 (20, 77–92) and USNM 385866 (15, 81–95.5), Houtman Abrolhos, Hummock I., 28°48'S, 114°02'E, trawled in 43 m; Nov 1980.

Diagnosis. A species of *Pseudocaranx* with posterior margin of upper jaw nearly vertical; lachrymal naked and expanded part of maxilla only partially covered with scales; caudal vertebra 14; gill rakers 7–10 upper, 19–21 lower, 27–31 total; scales in curved part of lateral line 53–66.

Description (values for holotype in parentheses). Dorsal fin rays VIII-I, (25) 23–25; anal-fin rays II-I, (21) 19–21; pectoral-fin rays (19) 18–20; vertebra 10 precaudal + 14 caudal; inferior vertebral foramina on caudal vertebra 7 or 8–10; scales in curved lateral line (61) 53–66; scales in straight LL (2) 2–11; scutes in straight LL (30) 19–31; total scales in LL (63) 58–74; total scales + scutes in LL (93) 86–99; developed gill rakers (8) 7–10 upper, (20) 19–21 lower, (28) 27–31 total, a single rudimentary raker rarely present on either end of gill arch.

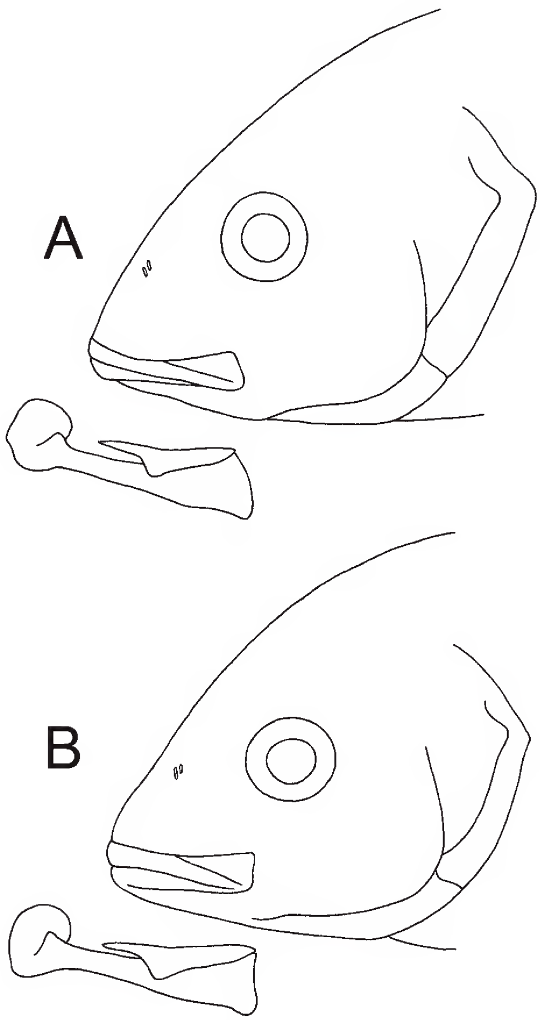

Figure 1. Head profiles and upper jaw shapes of *Pseudocaranx*: A, *P. wrighti*, ANSP 135418, 169 mm FL, Cockburn Sound, WA; B, *P. georgianus*, ANSP 138196, 200 mm FL, Cape Arid, WA.

Chest completely scaly; bases of dorsal and anal fins with a wide scaly sheath anteriorly; lachrymal naked; dorsal 3rd to half of expanded part of maxilla with a few embedded scales; cheeks, preopercle, opercle and interopercle covered with scales. Junction of curved and straight parts of lateral line below segmented dorsal-fin rays (13) 12–13; length of curved LL (0.57) 0.62–0.65 in straight LL; 1st dorsal-fin spines weak, the 3rd spine longest and slightly longer than height of 2nd dorsal-fin lobe; last dorsal- and anal-fin rays slightly longer and more widely spaced than adjacent rays; 1st anal-fin pterygiophore with anteroventral end short and bluntly rounded; 2nd dorsal-fin lobe (3.1) 2.8–3.1 in head length; pectoral fin of holotype and larger paratypes (0.94) 0.91–0.94 in head length. Upper jaw (2.7) 2.8–2.9 in head length, ending slightly in front of anterior margin of eye (fig. 3A); adipose eyelid weakly developed; lips slightly thickened and finely papillose. Jaw teeth (difficult to see clearly without dissection) in the holotype and 2 largest paratypes: upper jaw with a single row (21 left, 22 right) 19–22 of small conical teeth and (0) 1 inner tooth near symphysis; lower jaw with an outer row (21 left, 22 right) 25–27 of small conical teeth and an irregular inner row (11 left, 8 right) 13–18 of conical teeth on posterior half of jaw. (Based on observed changes in dentition with growth in other *Pseudocaranx* species, it is likely that an inner row of dentary teeth is absent in individuals of *P. dinjerra* larger than the holotype.) Vomerine tooth patch triangular-shaped, without a median posterior extension, and sparsely covered with small teeth.

Measurements of the holotype (in parentheses) and 2 paratypes, 221–230 mm, as percentages of FL: snout to D1O (39) 41–42; snout to D2O (54) 56; snout to P2O (35) 34–35; snout to A2O (57) 57; D1O to P2O (30) 30; D1O to A2O (39) 39–41; D2O to A1O (32) 33–35; D20 to A2O (32) 33–35; D2 base (35) 35–37; A2 base (31) 30–31; height dorsal-fin lobe (10) 10–11; height anal-fin lobe (10) 9–10; pelvic-fin length (15) 14–15; pectoral-fin length (33) 34; head length (31) 31–32; postorbital head length (12) 12–13; snout length (12) 12; upper jaw length (11) 11; eye diameter (7) 7–8; curved lateral-line length (24) 24–25; and straight lateral-line length (24) 24–25.

Preserved coloration. Holotype and larger paratypes uniformly pigmented, except spinous dorsal fin slightly dusky and opercle with a prominent dark pupil-sized spot at level of pupil. Juveniles with 7–9 dusky bands on body, extending ventrally from dorsum and fading out on ventral half of sides. Bands widest dorsally and equal or slightly wider than pale interspaces at mid-level of side. Dark opercular spot, intense, smaller than pupil and slightly vertically elongate. Inter-radial membranes of 1st dorsal fin dusky, densely peppered with small melanophores.

Life coloration (from an underwater photograph, probably of a subadult, from Shark Bay provided by J.B. Hutchins). Silvery blue-green dorsally, fading to silvery with iridescence below, faint mid-lateral yellow stripe from opercle to base of caudal fin; faint yellow stripe on base of dorsal fin extending slightly onto dorsum; prominent black spot on opercle at level of the pupil, approximately diameter of pupil and vertically elongate.

Distribution. Endemic to WA (fig. 4). Definitely known from Houtman Abrolhos (28°48'S) to off Cape Farquhar (23°42'S), and reported (Allen and Swainston, 1988) to North-West Cape (~21°47'S), but rare north of Shark Bay. Several photographs of *Pseudocaranx* taken by J.B. Hutchins off Green Head, WA (30°04'S) are tentatively identified as *P. dinjerra* based on the tiny size of the opercular spot. We know of no collections of *P. dinjerra* from well-sampled Rottnest I. (Hutchins and Pearce, 1994), located at 32°S, where both *P. wrighti* and *georgianus* occur; but its occurrence there might be expected.

Dispersal of temperate and subtropical species along the north-west coast of Australia is believed to be aided by counter-currents flowing inshore of the southward-flowing warm Leeuwin

Figure 2. *Pseudocaranx dinjerra*, Shark Bay, WA; photograph by J. B. Hutchins.

Current. Fluctuations of this current regimen – associated with glacial and interglacial periods may have contributed to reproductive isolation and eventual speciation of Western Australian endemic subtropical species (Hutchins, 1994; Hutchins, 2001a), presumably including the new *Pseudocaranx*.

Etymology. The trivial name dinjerra (west) is an Aboriginal word (Anon, 1969), in reference to the Western Australian endemic status of the species, and should be treated as an appositional noun.

Remarks. This species is most similar to *Pseudocaranx georgianus* but differs in having 14 caudal vertebra, and little overlap in number of anal-fin rays (Table 1) and total lateral-line scales (Table 3). Sheared PCA (fig. 5) revealed good separation of the three analyzed taxa. Although 11 of the 15 specimens of *P. georgianus* used in the analysis were obtained from the Sydney Fish Market, according to Kailola et al., 1993 the main commercial fishery is located in New South Wales waters where this species appears to be resident and non-migratory. *Pseudocaranx dinjerra* has a relatively longer snout and upper jaw (PC2) and shorter straight lateral line (PC3) than *P. georgianus* and *P.* sp. "*dentex*". However, fork length (PC1) accounted for 97.5% of the variation, while only 1.7% was associated with PC2 and PC3. Differences were subtle, yet consistent in the three groups.

Other than *P. wrighti*, the only other previously described Indo-Pacific *Pseudocaranx* with 14 caudal vertebra is *P. cheilio* Snyder, 1904, described from Honolulu, Hawaii. As mentioned in the introduction, at many locations in the Indo-west Pacific (including Hawaii and Easter Island) *Pseudocaranx* spp. invariably have either 14 or 15 precaudal vertebrae. In contrast, Yamaoka et al., 1991 found two distinct genetic morphs (identified by electrophoretic analysis) of "*P. dentex*" in Tosa Bay, Japan, each with different vertebral counts. The two morphs had strongly bimodal dorsal ray counts and the juveniles of one morph also appeared to have more distinct narrow bands on the body, leading these authors to strongly suspect that two species were involved. Masuda et al., 1995 also found significant mtDNA differences between the same two sympatric Japanese *Pseudocaranx* morphs. They implied that differences in spawning and recruitment locations and associated water temperatures may have affected the number of vertebrae. Vertebral counts are intraspecifically very constant in all other carangid genera (including 130+ species), so the situation in *Pseudocaranx* is very interesting if these morphs are not different species. Neither of the Japanese studies considered gill raker numbers, but our limited data indicate that they also differ between these two morphs. *Pseudocaranx cheilio* from Hawaii and the Japanese morph with 14 caudal vertebrae have higher numbers of lower gill rakers, 27–30 versus 19–21 in *P. dinjerra*.

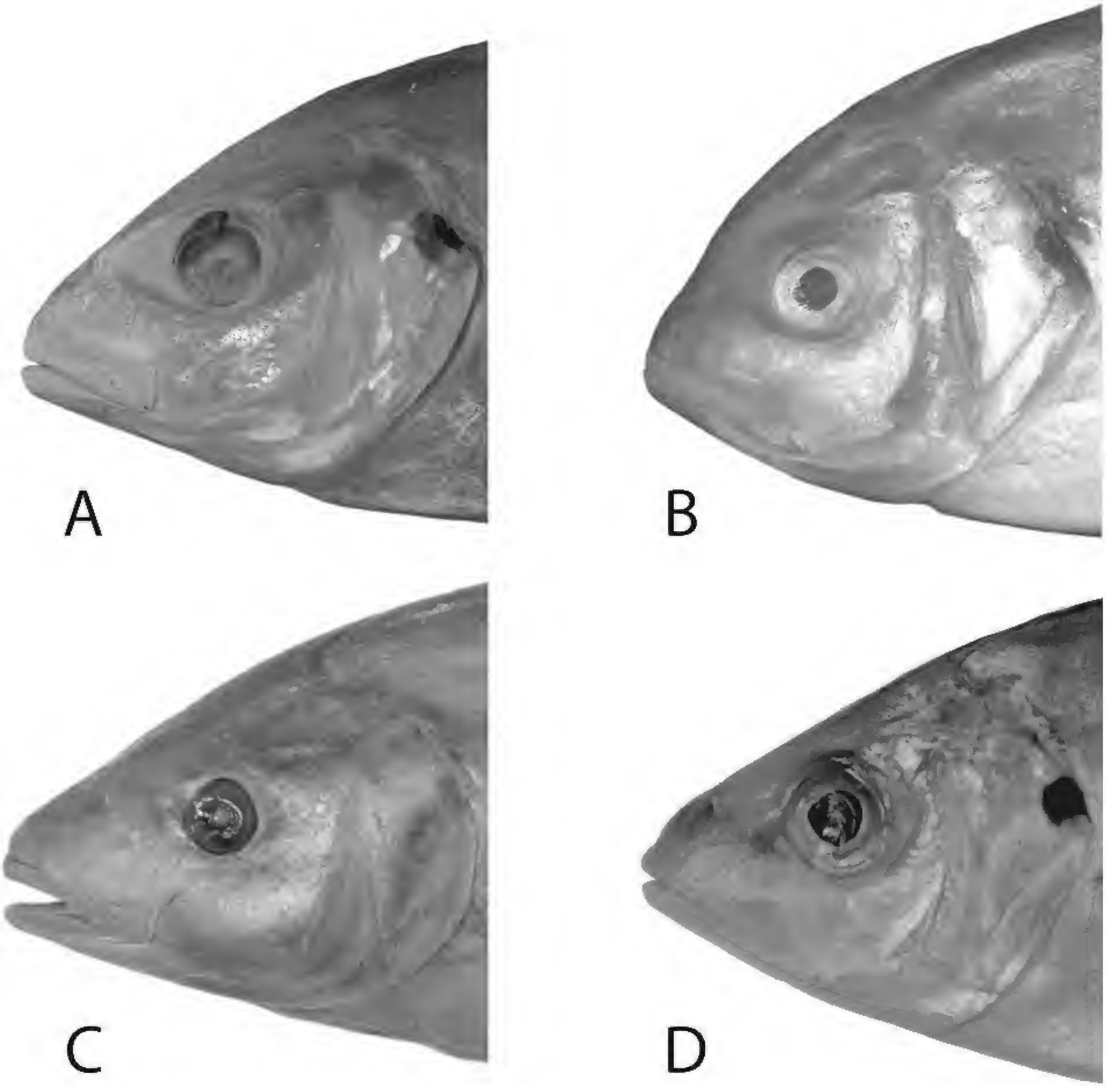

Figure 3. Heads of *Pseudocaranx* species: A, *P. dinjerra*, ANSP 148695, 230 mm FL, Cape Farquhar, WA; B, *P. georgianus*, USNM 385513, 275 mm FL, Sydney Fish Market; C, *P.* "*dentex*", CAS 16472, 404 mm FL, One Tree I.; D, *P. wrighti*, WAM P.14007-18, 124 mm FL, Rottnest I.

Pseudocaranx georgianus Cuvier, 1833

Figures 1B, 3B, 4, 5; Tables 1–3

Caranx georgianus Cuvier in Cuvier and Valenciennes, 1833: 85 (orig. descr. King George Sound, WA; syntypes MNHN 5854); Ogilby, 1893: 80, pl. 24 (descr.; biology; fisheries; edibility); James and Stephenson, 1974: 402, fig. 2 (taxonomic status; synonymy; descr. based, in part, on *Pseudocaranx wrighti*); Hutchins, 1979: 38, color pl. 21 (Rottnest I.; behaviour; distrib.); Smith-Vaniz et al., 1979: 12 (syntypes listed).

Caranx platessa Cuvier in Cuvier and Valenciennes, 1833: 84 (orig. descr. "La mer des Indes;" holotype MNHN 5856); Günther, 1860: 440 (as first reviser, listed in synonymy of *C. georgianus*); James and Stephenson, 1974: 402, fig. 3 (discussion of type locality, probably Geographe Bay, WA; considered to be a synonym of *C. georgianus*); Smith-Vaniz et al., 1979: 17 (holotype listed).

Caranx nobilis Macleay, 1881: 532 (orig. descr. Port Jackson, NSW, Australia; holotype MAMU, apparently lost).

Usacaranx archeyi Griffin, 1932: 130, pl. 22 (orig. descr. North side of Motuihi I., Hauraki Gulf, New Zealand; Holotype AIM 262).

Usacaranx georgianus. Roughley, 1951: 57, color pl. 22 (biology and fisheries); Scott et al., 1974: 201, unnumb. fig. (desc.; distrib.).

Pseudocaranx dentex (non Bloch and Schneider). May and Maxwell, 1986: 300, unnumb. color photo. (descr.; common name;

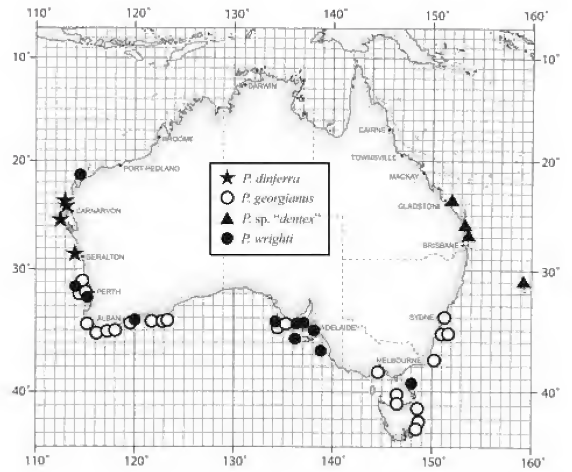

Figure 4. Australian distributions of *Pseudocaranx* species based on material examined.

distrib.); Okiyama, 1988: 474, unnumb. pl. (descr.; early stage); Paxton et al., 1989: 582 (partial synonymy; distrib. in part, includes range of *P. dinjerra*); Kuiter, 1993: 176, unnumb. color photos (descr.; distrib.; in part, includes ranges of other spp.); Gomon et al., 1994: 584, unnumb. color photos (descr.; distrib.; partial synonymy); Smith-Vaniz, 1999: 2730 (descr.; synonymy; distrib. in part, includes ranges of other spp.); Hutchins, 2001b: 33 (listed).

Material examined. 111 specimens, 45–495 mm FL. WAM P.14755 (170), 0.8 km E. Lancelin I., 31°33'S, 115°19'E. WAM P.14054 (187) and WAM P.14762-3 (2, 122–132), Rottnest I. ANSP 148694 (234) and ANSP 178913 (3, 170–186) Perth vicinity. AMNH 55688 (2, 187–200) and ANSP 135419 (2, 145–139), Fremantle, Cockburn Sound. MNHN 5856 (217), holotype of *Caranx platessa*, "mer des Indies," probably Geographe Bay. WAM P.25064-004 (4, 45–90), Hardy Inlet. WAM P.20253 (193), Broke Inlet. WAM P.21824-25 (2, 160–162), Cherryup, 34°58'S, 117°26'E. WAM P.20026 (219), Wilson Inlet. MNHN 5854 (2, 142–166), syntypes of *Caranx georgianus*, King George Sound. AMS IA.653 (210), Albany, King George Sound. WAM P.21673 (193), Brewer Bay, 34°24'S, 119°26'E. WAM P.21681 (153), Stokes Inlet. ANSP 148693 (2, 102–174) and ANSP 148697 (7, 72–132), Duke of Orleans Bay. ANSP 138196 (2, 193–200), Cape Arid. ANSP 138194 (189) and ANSP 138195 (2, 114–170), Isralite Bay. ANSP 138197 (192), Coffin Bay. ANSP 49316-18 (3, 181–185), Melbourne. ANSP 135420 (82 C&S), TMH D.197 (132), TMH D.530 (4, 90–108), TMH D.531 (189), TMH D.774 (272), TMH D.830 (187), TMH D.1029 (67), USNM 222104 (15, 140–227), Tasmania. BMNH 1896.6.17.49-52 (4, 135–495), Flinders I., 33°43'S, 134°31'E. AMS I.19890-002 (3, 201–263), Nadgee Nature Reserve, 37°26'S, 149°54'E. AMS I.28734-002 (4, 191–210), Green Cape, Bittangabee Bay. ANSP 153525 (8, 156–180) Jervis Bay. USNM 177016 (2, 255–294), New South Wales, no specific locality. ANSP 138198 (2, 220–246), ANSP 147861 (2, 265–276), ANSP 153773 (6, 315–378), USNM 385513 (275), Sydney Fish Market. ANSP 135421 (2, 94–95 C&S), CAS-SU 7433 (2, 149–150), CAS-SU 8321 (163) Sydney. ANSP 147826 (2, 144–162) 24 km E. Sydney Harbour. AIM 262 (88), holotype of *Usacaranx archeyi*, N side of Motuihi I., Hauraki Gulf, New Zealand.

Diagnosis. A species of *Pseudocaranx* with posterior margin of upper jaw nearly vertical (fig. 1B); lachrymal naked and expanded part of maxilla naked or with a few partially embedded scales; caudal vertebra 15; gill rakers 8–13 upper, 19–23 lower, 28–35 total; scales in curved part of lateral line 55–78.

Distribution. Known from New Zealand and the southern half of Australia from NSW to just north of Perth, WA, including Rottnest I.

Remarks. Pseudocaranx dentex, described from Brazil, is the oldest available name for any species of *Pseudocaranx* while *P. georgianus* is the oldest name for a nominal species with an Indo-Pacific type locality. The type specimens of both species have 15 caudal vertebrae, as do all specimens from the Atlantic and western Indian Oceans and some from Japan. Australian specimens with the same vertebral count have fewer total gill rakers (except those from Queensland and Lord Howe Island, see Table 2) than do specimens from the latter localities, which have 35–42 gill rakers. Unlike similarly sized specimens of *P. dentex* from widely separate Atlantic localities, large adults (>350 mm FL) from southern Australia and New Zealand usually have a pronounced hump on their foreheads that is correlated with hyperostosis of the supraoccipital bone, do not have blunt snouts (see following remarks), and the dark opercular spot, although variable in size and shape, is also usually diffuse and noticeably larger than the pupil diameter. Because of these differences, *P. georgianus* is here recognized as a valid species.

Pseudocaranx **sp. "dentex"**

Figures 3C, 4, 5; Tables 1–3

? *Scomber dentex* Bloch and Schneider, 1801: 30 (orig. descr.; Rio de Janeiro, Brazil; holotype ZMB 14112).

? *Usacaranx insulanorum* Whitley, 1937: 223, pl. 13, fig. 2 (orig. descr.; Elizabeth Reef; holotype lost).

Caranx nobilis. Grant, 1982: 302, color pl. 147 (brief descr., Qld).

Pseudocaranx dentex. Randall et al., 1990: 164 (misident. in part; brief descr.).

Material examined. 38 specimens, 162–860 mm FL. Qld, Australia: CAS 16472 (7, 404–432), One Tree I.; QMB I.13732 (321), Noosa, 26°23'S, 153°07'E; QMB I.19416 (296), Cape Moreton. Lord Howe I.: AMS I.5761-001 (673); AMS I.7395-006 (18, 162–199); AMS I.17178-045 (195); AMS I.17395-015 (2, 181–197); AMS I.23674-001 (860); CAS-SU 9158 (2, 170–198); BPBM 14833 (4, 145–210).

Remarks. Unlike *P. georgianus* from southern Australia and New Zealand, no evidence of hyperostosis of the supraoccipital is apparent in any of the large specimens available from One Tree I. In addition to having more gill rakers (Table 2), adults from off Queensland and Lord Howe Island do not have the blunt snouts (fig. 3B) that are characteristic of many large individuals from New Zealand (Ayling and Cox, 1982, pl. 19) and southern Australia (Ogilby, 1893, pl. 24). As discussed under "Remarks" for *P. dinjerra*, sheared PCA analysis revealed consistent but subtle differences between all three *Pseudocaranx* groupings (fig. 5).

The fish from Queensland and Lord Howe Island listed above likely represent a fourth Australian *Pseudocaranx* species but final determination requires additional study, especially

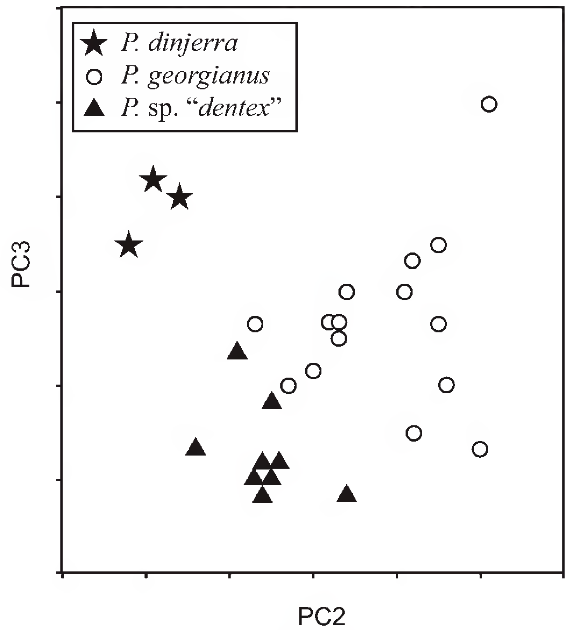

Figure 5. Sheared principal component analysis of 22 measurements for 3 *Pseudocaranx* taxa. PC2 loadings were associated with snout and upper jaw lengths, while PC3 was associated with straight lateral line and anal-fin base lengths; see Material and methods section for discussion of measurements used.

mitochondrial DNA analyses. James, 1980 reported limited movement of tagged *Pseudocaranx* off north-east New Zealand, so it is possible that fish from Queensland and Lord Howe Island are isolated from those in southern Australia and New Zealand. We are currently unable to distinguish them from *P. dentex* from the Atlantic Ocean and South Africa, or from Japan *Pseudocaranx* sp. with 15 caudal vertebra. Two other antitropical Indo-Pacific carangids, *Seriola lalandi* Valenciennes and "*Caranx*" *equula*, also have similarly wide disjunct distributions, so this zoogeographic pattern is not unique. If Atlantic *Pseudocaranx* are indeed conspecific with those from Queensland offshore reefs and Lord Howe Island, then the oldest available name for them is *P. dentex*. If a different scientific name is required, one possibility is *Usacaranx insulanorum* Whitley. That nominal species was described (Whitley, 1937) from Elizabeth Reef based on a single individual. Unfortunately, the holotype is not extant (Eschmeyer, 1998) and no additional specimens are available from the type locality that would allow detailed comparisons. The original description included no vertebral count but the reported high number of gill rakers (14+25) agrees with specimens from One Tree and Lord Howe Islands.

Grant's, 1982 photograph (colour pl. 147) of a postmortem specimen from Noosa Heads, Queensland shows a fish with mostly yellow dorsal and anal fins and a faint yellow mid-lateral body stripe. The *Pseudocaranx* color photograph (Plate IV-19) in Randall et al., 1990 is misleading because it was taken at Easter Island (Randall, pers. comm.).

Pseudocaranx wrighti Whitley, 1931

Figures 1A, 3D, 4; Tables 1–3

Usacaranx georgianus wrighti Whitley, 1931: 317 (orig. descr. 40 mi. west of Kingston, South Australia; Holotype AMS I.10336).

Pseudocaranx wrighti. May and Maxwell, 1986: 301, unnumb. photo. (descr.; common name; distrib.); Paxton et al., 1989: 582 (synonymy; distrib.); Kuiter, 1993: 176, unnumb. color photos (descr.; distrib.); Gomon et al., 1994: 585, unnumb. color photo. (descr.; distrib.); Hutchins, 1997: 247 (listed; Houtman Abrolhos); Hutchins, 2001b: 33 (listed).

Material examined. 125 specimens, 46–196 mm FL. CSIRO C.2751 (119), Exmouth Gulf; ANSP 134668 (4, 105–143), ANSP 135418 (8, 141–169), WAM P.14007-18 (11, 100–135), WAM P.14019-26 (8, 110–144), WAM P.14043-53 (11, 119–150), WAM P.14055 (112), Rottnest I. vicinity; ANSP 153537 (6, 150–176), ANSP 182762 (4, 172–196), Perth vicinity; WAM P.27679 (182), Swan-Avon R.; AMS I.10336 (122.5, holotype of *Usacaranx georgianus wrighti*), W of Kingston, 36°50'S, 139°20'E; AMNH 37652 (2, 169–181), Cockburn Sound, Fremantle; ANSP 148691 (30 of 61, 46–159), Sepia Depression off Garden I., 32°08'S, 115°37'E; SAMA 196 (2, 116–139), Doubtful I. Bay; ANSP 145073 (186), Coffin Bay; SAMA 3110 (2, 120–122), SAMA 3147 (144), off Port Lincoln; SAMA 4777 (145) Adelaide outer harbour; SAMA 3930 (17, 97–125), St. Vincent Gulf; AMS I.20194-032 (9, 92–123), Investigator Strait; SAMA 3620 (164), Kangaroo I.; AMS I.10397 (125), Flinders I., 33°45'S, 134°30'E; TMH D.535 (2, 94–103), Flinders I., 39°50'S, 148°00'E.

Diagnosis. A species of *Pseudocaranx* with posterior margin of upper jaw canted posteroventrally (fig. 1A); lachrymal and expanded part of maxilla densely covered with scales; caudal vertebra 14; gill rakers 10–15 upper, 24–28 lower, 35–43 total; scales in curved part of lateral line 37–48.

Distribution. Endemic to Australia (fig. 4); eastern Bass Strait extending W at least to Rottnest I., WA. A single collection of *P. wrighti* from Exmouth Gulf (see material examined) at approximately 22°S extends its distribution well into that of *P. dinjerra*, if the record is not due to a specimen mix-up.

Remarks. This species differs from other Australian congeners as indicated in the identification key and Table 3. It also differs in having a well defined opercular spot that is nearly solid black and approximately the diameter of the pupil (fig. 3D), in never developing a yellow mid-lateral body stripe, and second dorsal and anal fins transparent or dusky green, never with yellow pigmentation. *Pseudocaranx wrighti* is the smallest species of *Pseudocaranx*, rarely exceeding 200 mm FL.

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We thank the curators and collection managers of the ichthyological collections cited herein for specimen loans and other courtesies during visits to their respective institutions. Michael Walker, Western Australian Fisheries Department, also provided specimens that were critical to this study. Thanks are due to Sandra J. Raredon and Kyle Luckenbill for digital specimen images, Barry J. Hutchins for providing color slides of Australian *Pseudocaranx*, and both he and Rudie Kuiter for sharing their observations on *Pseudocaranx* and patiently answering our questions. Tim M. Berra provided help in

Table 1. Frequency distributions of segmented fin rays and caudal vertebrae in Australian species of *Pseudocaranx*.

	Dorsal-fin rays										Anal-fin rays								
Species	22	23	24	25	26	27	28	29	X	SD	18	19	20	21	22	23	24	X	SD
wrighti	4	31	52	25	3				23.9	0.9	1	1	41	63	8	1		20.7	0.7
dinjerra		4	21	14					24.3	0.6		1	15	23				20.6	0.6
georgianus				11	51	35	11	1	26.4	0.8				4	39	51	15	22.7	0.8
sp. "*dentex*"																			
Queensland				2	7				25.8	0.4				3	6			21.7	0.5
Lord Howe I.			1	8	16	2			25.7	0.7				3	21	3		22.0	0.5

	Pectoral-fin rays							Caudal vertebrae	
Species	17	18	19	20	21	X	SD	14	15
wrighti	4	69	12			18.1	0.4	113	
dinjerra		12	26	1		18.7	0.5	39	
georgianus		6	59	16		19.1	0.5		109
sp. "*dentex*"									
Queensland				8	1	20.1	0.3		9
Lord Howe I.				6	2	20.3	0.5		24

Table 2. Frequency distributions of developed gill rakers in Australian species of *Pseudocaranx*.

	Upper gill rakers											Lower gill rakers											
Species	7	8	9	10	11	12	13	14	15	X	SD	19	20	21	22	23	24	25	26	27	28	X	SD
wrighti				1	2	26	35	15	1	12.8	0.9						5	24	35	12	4	25.8	0.9
dinjerra	3	16	19	1						8.5	0.7	3	24	12								20.2	0.6
georgianus		2	20	40	24	1	1			10.1	0.9	1	2	19	49	17						21.9	0.8
sp. "*dentex*"																							
Queensland						4	3	2		12.8	0.8						2	3	4			25.2	0.8
Lord Howe I.					1	7	15	1		12.7	0.6							7	15	2		25.8	0.6

	Total gill rakers																
Species	27	28	29	30	31	32	34	35	37	38	39	40	41	42	43	X	SD
wrighti								2	14	19	17	19	4	1	1	38.6	1.5
dinjerra	4	12	16	6	1											28.7	1.0
georgianus		2	1	11	13	29	8	1								32.0	1.4
sp. "*dentex*"																	
Queensland									3	1	3	1				38.0	1.3
Lord Howe I.									1	3	7	10	3			38.7	1.0

selecting the scientific name for the new species. The first author is also grateful for an Australian Museum Visiting Museum Fellowship that provided much of the impetus for this research. The manuscript benefited from comments of Martin F. Gomon, Steven J. Walsh, and two anonymous reviewers.

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Table 3. Frequency distributions of lateral-line scales and scutes in Australian species of *Pseudocaranx*.

	Scales in curved lateral-line																						
	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79		
Species	38	40	42	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	X	SD
wrighti	3	11	22	35	12	2																	42.7	2.1
dinjerra									1	2	9	10	9	3	5								60.2	3.0
georgianus										1	3	–	10	10	12	16	13	8	1	3	1		66.6	4.4
sp. "*dentex*"																								
Queensland																	2	2	–	3	2		73.6	3.5
Lord Howe I.														1	–	1	3	4	2	–	2	1	72.1	4.1

	Scales in straight lateral-line														
	2	4	6	8	10	12	14	16	18	20	22	24	26		
Species	3	5	7	9	11	13	15	17	19	21	23	25	27	X	SD
wrighti	1	6	20	29	17	9	3							8.6	2.5
dinjerra	1	10	18	8	2									6.5	1.8
georgianus				5	7	16	13	15	15	4	2	–	1	15.2	3.6
sp. "*dentex*"															
Queensland			1	4	3	1								9.6	1.6
Lord Howe I.				1	3	3	3	3	1					13.3	2.9

	Scutes in straight lateral-line										
	16	18	20	22	24	26	28	30	32		
Species	17	19	21	23	25	27	29	31	33	X	SD
wrighti	5	12	22	25	17	4				21.7	2.5
dinjerra		1	2	8	8	11	6	3		25.3	2.9
georgianus	3	12	20	25	9	8	1			22.0	2.6
sp. "*dentex*"											
Queensland					1	2	3	2	1	28.2	2.2
Lord Howe I.					5	2	6	1		27.0	2.0

	Total scales in lateral-line																										X	SD
	44	46	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94		
Species	45	47	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93	95		
wrighti	4	6	12	20	23	13	5	2																			51.4	3.1
dinjerra								1	1	4	8	11	5	6	2	1											66.7	3.5
georgianus															2	5	9	7	14	18	9	5	2	4	1	2	81.8	4.9
sp. "*dentex*"																												
Queensland																		2	2	–	2	3					83.1	3.4
Lord Howe I.																			1	–	9	1	2	–	1		85.4	2.9

	Total scales + scutes in lateral-line																			
		68	71	74	77	80	83	86	89	92	95	98	101	104	107	110	113	116	119		
Species	67	70	73	76	79	82	85	88	91	94	97	100	103	106	109	112	115	118		X	SD
wrighti	3	9	36	24	13															73.1	2.7
dinjerra								5	10	18	3	3								92.0	3.0
georgianus										2	5	16	17	14	11	8	5			103.8	5.2
sp. "*dentex*"																					
Queensland											1	–	–	1	3	2	2	–	1	111.3	4.3
Lord Howe I.															3	6	2	3		112.4	3.2

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